Mahindra
Rise.

Mahindra

TRACTORS

WORKSHOP MANUAL

(eMax S20 HST)

HST TRACTOR

eMax S20 HST

WORKSHOP MANUAL

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Chapter 1 .Introduction

This tractor service manual is for qualified service personnel engaged in servicing and overhauling eMax S20 HST tractor. Use of this publication is not recommended for field operators since they usually do not have access to special tools and shop equipment essential for most servicing.

Servicing procedures outlined herein contain sufficient information to return all component parts of a tractor to new condition. In discussion of each component parts, it is assumed that a complete overhaul is been performed consequently,

complete disassembly and reassembly are outlined. The mechanic is relied upon to decide how far disassembly must be carried when complete overhaul is not required.

Study unfamiliar service procedures thoroughly and clearly understood before attempting disassembly. Specific data essential for proper overhaul, such as running clearances and torque value, have been provided in interline of Inspection and reassembly procedures of each group section.

This manual was compiled from latest information available at time of publication.

Manufacturer reserves the right to make changes at any time without notice.

Whenever the terms "left“ and "right" are used, They means as viewed by the operator when seated in the operator's seat.

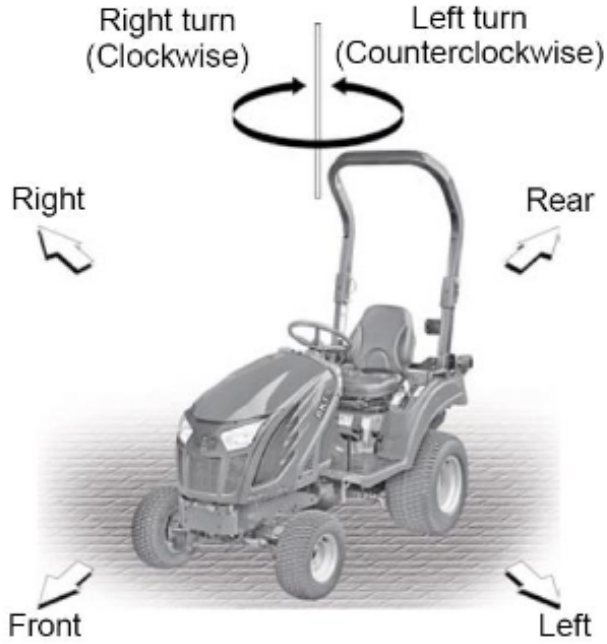


Illustration A

(Front, Rear, Left, and Right Portion)

SAFETY INSTRUCTION

ALWAYS PRACTICE SAFETY BY THINKING BEFORE ACTION

AVOID FIRE HAZARDS.

-Keep fire extinguishers easily available and in good operating condition.

All relevant personnel should know how to operate fire fighting equipment.

-Keep a first aid kit in an easily accessible location.

-Do not smoke while handling fuel,or other highly flammable material.

-Do not use an open pail for transporting fuel.

-Use of an approved fuel container.

-Dispose of all fuel-soaked rags in covered containers where cigarettes cannot be dropped carelessly.

-Do not smoke and avoid open flame when charging,jumping,or boosting batteries.

-Batteries give off gas which is flammable and explosive.

-Do not charge batteries in a closed area. Provide proper ventilation to avoid explosion of accumulated gases.

Avoid acid burns.

-Wear safety goggles when handling battery electrolyte.It contains sulfuric acid which is a poison and can cause blindness.Avoid it contacting eyes,skin,or clothing. sulfuric acid will eat through clothing and can cause severe burns to skin.

AVOID HIGH-PRESSURE FLUIDS

1) Before beginning work on hydraulic system components,turn off engine and operate hydraulic control levers to relieve internal hydraulic pressure.

2) Oil under pressure can penetrate skin and lead to personal injury.Treat sources of oil pressure with extreme care,wearing safety goggles.

3) If hydraulic leak develops,correct immediately.Escaping hydraulic oil can have extremely high pressure. A stream of high pressure oil may easily penetrate skin just like modern needless vaccination equipment,but with the exception that hydraulic fluid may cause blood poisoning. It is imperative that connections are tight and that all lines and pipes should be in good condition. If injured by escaping hydraulic fluid,see a doctor at once.

STAY CLEAR OF PTO

1) Entanglement in rotating drive line can cause serious injury or death.
2) Keep tractor master shield and drive line shield in place at all times except for special applications as directed in the implement operator's manual.

3) Wear fairly tight fitting clothing. Stop the engine and be sure PTO driveline is stopped before making adjustment, connections or cleaning out PTO drive equipment.

SERVICE TIRES SAFELY

Tire changing can be dangerous and should be done by trained personnel using proper tools and equipment.

Do not re-inflate a tire that has been run flat or seriously under-inflated. Have it checked by qualified personnel.

Use wheel handling equipment adequate for weight involved when removing and installing wheels.

WARNING SIGNS IN THIS MANUAL

The following warning symbols in this manual draw additional attention to items of importance for the safe and correct operation of the tractor.

SIGN	MEANING OF SIGN
DANGER	Serious hazard with a very high level of risk of either serious injury or death
WARNING	Hazard or unsafe practice that can lead to severe injury or death.
CAUTION	Hazard or unsafe practice that can lead in injury or death.
IMPORTANT	Instructions for the correct operation of the machine which, if followed, will ensure that it performs at it's best

SAFETY SIGNS

RECOGNIZE SAFETY INFORMATION

This symbol, Safety-Alert Symbol, means ATTENTION! YOUR SAFETY IS INVOLVED. The message that follows the symbol contains important information about safety. Carefully read the message.

SIGNAL WORDS

A signal word—**DANGER, WARNING OR CAUTION**—is used with safety alert symbol.

DANGER identifies the most serious hazards. Safety signs with signal Word —DANGER OR WARNING—are typically near specific hazards. General precautions are listed on CAUTION safety signs.

DANGER

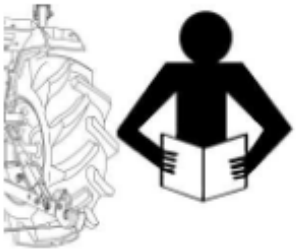
WARNING

CAUTION

READ SAFETY INSTRUCTION

Carefully read all safety instructions given in this manual for your safety. Tempering with any of the safety devices can cause serious injuries or death. Keep all safety signs in good condition. Replace missing or damaged safety signs.

Keep your tractor in proper condition and do not allow any unauthorized modifications to be carried out on the Tractor, which may impair the function/safety and affect Tractor life.



PROTECTION CHILDREN

Keep children and others away from the Tractor while operating.

BEFORE YOU REVERSE

- Look behind Tractor for children.
- Do not let children to ride on Tractor or any implement.

USE OF ROPS AND SEAT BELT

The Roll Over Protective Structure(ROPS) has been certified to industry and/or government standards. Any damage or alternation to the ROPS, mounting hard-ware, or seat belt voids the certification and will reduce or eliminate protection for the operator in the event of a roll-over. The ROPS, mounting hardware, and seat belt should be checked after the first 100 hours of Tractor and every 500 hours thereafter for any evidence of damage, wear or cracks. In the event of damage or alteration, the ROPS must be replaced prior to further operation of the Tractor.

The seat belt must be worn during machine operation when the machine is equipped with a certified ROPS.

Failure to do so will reduce or eliminate protection for the operator in the event of a roll over.

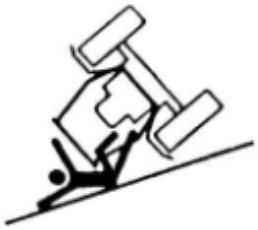
PRECAUTION TO AVOID TIPPING

Do not drive where the Tractor could slip or tip.

Stay alert for holes and rocks in the terrain, and other hidden hazards.

Slow down before you make a sharp turn.

Driving forward out of a ditch or mired condition could cause Tractor to tip over backward. Back out of these situations if possible.

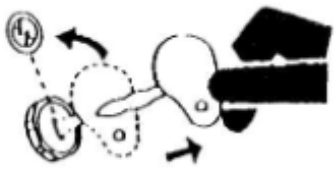


PARK TRACTOR SAFELY

Before working on the Tractor ;

Lower all equipment to the ground.

Stop the engine and remove the key.



KEEP RIDERS OFF TRACTOR

Do not allow riders on the Tractor.

Riders on Tractor are subject to injury such as being stuck by foreign objects and being thrown off of the Tractor.

HANDLE FUEL SAFELY-AVOID FIRES

Handle fuel with care; it is highly flammable. Do not refuel the Tractor while smoking or near open flame or sparks.

Always stop engine before refueling Tractors.

Always keep your tractor clean of accumulated grease, and debris. Always clean up spilled fuel.

STAY CLEAR OF ROTATING SHAFTS

Entanglement in rotating shaft can cause serious injury or death.

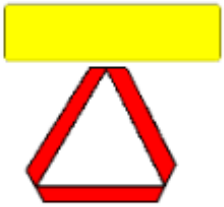
Keep PTO shield in place at all times.

Wear close fitting clothing. Stop the engine and be sure PTO drive is stopped before making adjustments, connections, or cleaning out PTO driven equipment.

ALWAYS USE SAFETY LIGHTS AND DEVICES

Use of hazard warning lights and turn signals are recommended when towing equipment on public roads unless prohibited by state or local regulations.

Use slow moving vehicle (SMV) sign when driving on public road during both day & night time, unless prohibited by law.



PRACTICE SAFE MAINTENANCE

Understand service procedure before doing work.

Keep the surrounding area of the Tractor clean and dry.

Do not attempt to service Tractor when it is in motion.

Keep body and clothing away from rotating shafts.

Always lower equipment to the ground. Stop the engine.

Remove the key. Allow Tractor to cool before any work repair is caused on it.

Securely support any Tractor elements that must be raised for service work.

Keep all parts in good condition and properly installed.

Replace worn or broken parts. Replace damage/missing decals.

Remove any buildup of grease or oil from the Tractor.

Disconnect battery ground cable(−) before making adjustments on electrical systems or welding on Tractor.

AVOID HIGH-PRESSURE FLUIDS

Escaping fluid under pressure can penetrate the skin causing serious injury. Keep hands and body away from pinholes and nozzles, which eject fluids under high pressure. If ANY fluid is injected into the skin, consult your doctor immediately.

PREVENT BATTERY EXPLOSIONS

Keep sparks, lighted matches, and open flame away from the top of battery. Battery gas can explode.

Never check battery charge by placing a metal object across the poles.

PREVENT ACID BURNS

Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, cause holes in clothing and cause blindness if found entry into eyes.

For adequate safety always;

1. Fill batteries in a well-ventilated area.
2. Wear eye protection and acid proof hand gloves.
3. Avoid breathing direct fumes when electrolyte is added.
4. Do not add water to electrolyte as it may splash off causing severe burns.

If you spill acid on yourself;

1. Flush your skin with water.
2. Flush your eyes with water for 10-15 minutes.

Get medical attention immediately.

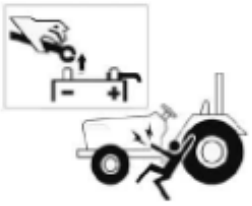
SERVICE TRACTOR SAFELY

Do not wear a necktie, scarf or loose clothing when you work near moving parts. If these items were to get caught, severe injury could result.

Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.

BATTERY DISCONNECT

When working with your tractors electrical components you must first disconnect the battery cables. To ensure that there are no accidents from sparks you must first disconnect the negative battery cable.

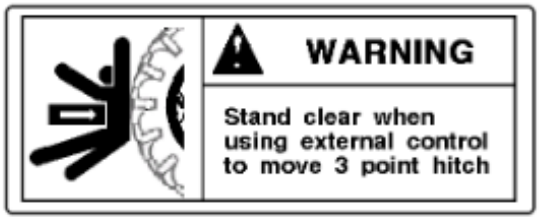


WORK IN VENTILATED AREA

Do not start the tractor in an enclosed building unless the doors & windows are open for proper ventilation, as tractor fumes can cause sickness or death. If it is necessary to run an engine in an enclosed area remove the exhaust fumes by connecting exhaust pipe extension.

Using external control

Stand well clear of the rear linkage and implements when using the hitch remote switches or injury can result from moving parts.



TRACTOR RUNAWAY

1.The tractor can start even if the transmission is engaged position causing Tractor to runaway and serious injury to the people standing nearby the tractor.

For additional safety keep the pull to stop knob (fuel shut off control) in fully pulled out position. Transmission in neutral position, Foot brake engaged and PTO lever in disengaged position while attending to Safety Starter Switch or any other work on Tractor.

SAFETY STARTER SWITCH

1. Clutch operated safety switch is provided on all Tractors which allow the starting system to become operational only when the Clutch pedal is fully pressed.
2. Do not By-pass this safety starter switch or work on it. Only Authorized Dealers are recommended to work on safety starter switch.
3. On some models Safety Starter switch is provided on transmission High-low shifter lever and in PTO shifter lever. The tractor can be started only if High-low shifter lever is in neutral position.

Caution

To avoid injury, always engage park brake, ensure HST is in Neutral position and PTO switch is off when starting or running the engine.

Safety Starter Switch is to be replaced after every 2000 hours/4 years, whichever is earlier

SAFETY DECALS

The following safety decals ARE INSTALLED ON THE MACHINE.

If a decal become damaged, illegible or is on the machine, replace it. The decal part number is listed in the parts lists.

WARNING

- Before starting and operating know the operating and safety instructions in the operators Manual and on the tractor.
- Clear the area of bystanders.
- Locate and know operation of controls.
- Start engine only from Operator's seat with depressed Brake pedal, transmission in the neutral, PTO disengaged and hydraulic control in lower position
- **Slow down on turns, rough ground and slopes to avoid upset.**
- Do not permit anyone but the operator to ride on the tractor. There is no safe place for rider.
- Lock brakes together, use warning lights and SMV emblem while driving on roads.
- Lower equipment, place gear shift levers in neutral, stop engine, remove the key and apply parking brake before leaving the tractor seat.
- **Air pressures are specified by the manufacturer.**

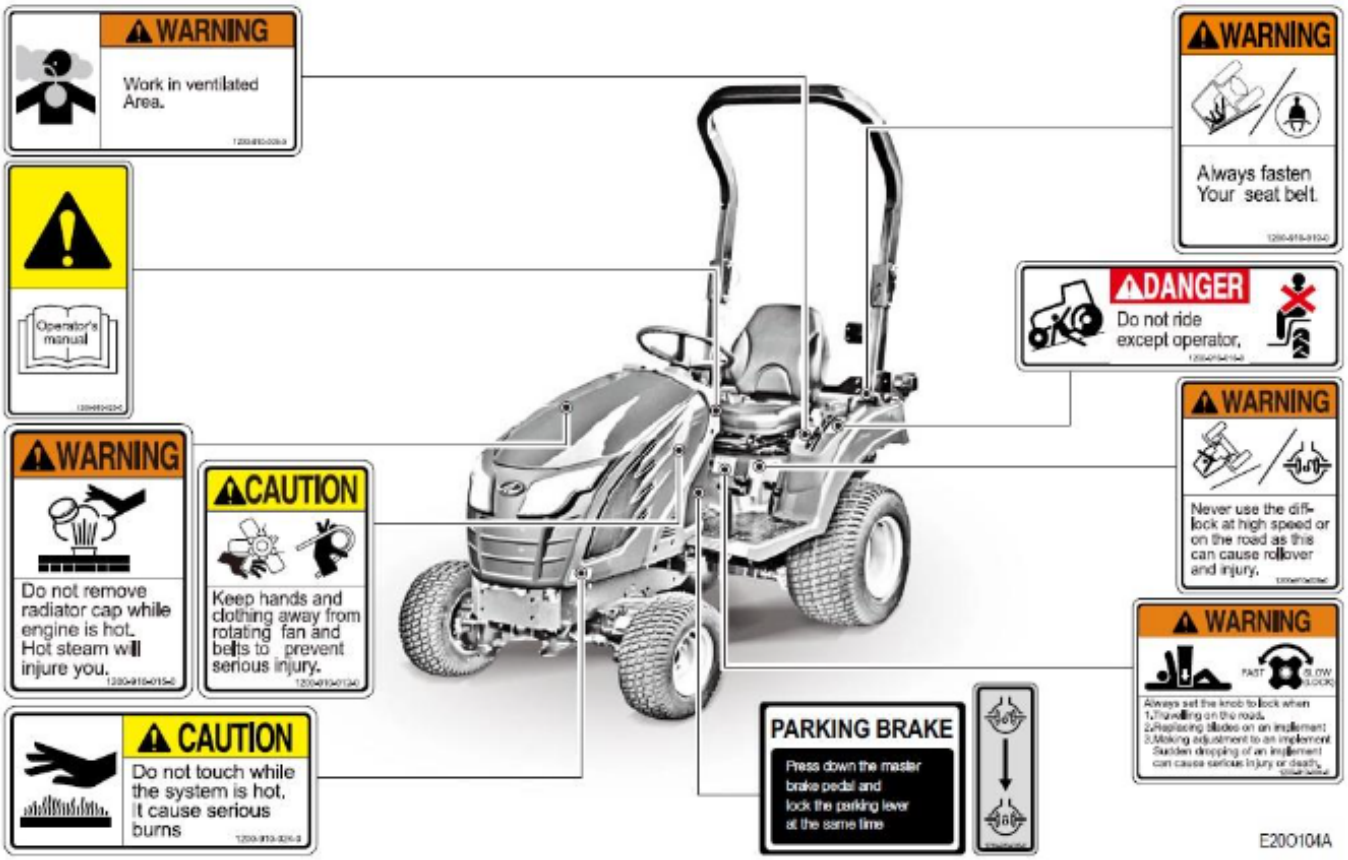
FAILURE TO FOLLOW ANY OF THE INSTRUCTIONS ABOVE CAN CAUSE SERIOUS INJURY TO THE OPERATOP

DECALS ON THE DASH COVER

WARNING
Additions, alterations, cracking, damage or corrosion to this structure may adversely affect the performance of the ROPS.
DANGER
This Tractor may tip over unexpectedly and quicker than an operator is able to jump free
1.Never operate a tractor without a proper Roll over Protection Structure(ROPS)
2.Always wear your seat belt when operating this tractor equipped with roll over protection.
3.Never pull from above or from the rear axle.
4.Do not operate the tractor on steep slopes or near drop offs
5.Avoid sharp high speed turns
Serious injury or death may result from tractor upsets.
WARNING
Death or injury may result if this tractor over turns with the ROPS in the folded down position.
Operate this tractor with the ROPS folded down only when necessary.
Do not wear seat belt if operated with ROPS folded down
WARNING
Do not refuel the tractor while smoking or near naked flame or sparks, always stop engine before refueling tractors.
EPA REGULATION
USE ULTRA LOW SULFUR FUEL ONLY
WARNING
• Start engine only from operators seat. If safety start switch is by passed engine can start with transmission in gear.
• Do not connect or short across terminal on starter solenoid.
• Attach booster cables as shown on battery decal and operators manual.
Starting in gear causing runaway can result in serious injury.
WARNING
Always apply the park brake when parking.
Failure to do so can cause accidents and damages.
WARNING
Do not use the accelerator lever except working on the field.
E2001103A

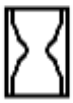
DANGER
Rotating driveline contact can cause death.
KEEP AWAY!
Keep all drive line, Tractor and equipment shields in place during operation.
WARNING
Attach implements and trailers to the tractor only using the prescribed drawbar or hitch.

DECALS ON THE CHASSIS


WARNING
Work in ventilated Area.
Operator's manual
WARNING
Do not remove radiator cap while engine is hot. Hot steam will injure you.
CAUTION
Keep hands and clothing away from rotating fan and belts to prevent serious injury.
CAUTION
Do not touch while the system is hot, it cause serious burns
WARNING
Always fasten Your seat belt.
DANGER
Do not ride except operator.
WARNING
Never use the diff-lock at high speed or on the road as this can cause rollover and injury.
WARNING
PARKING BRAKE
Press down the master brake pedal and lock the parking lever at the same time
E200104A

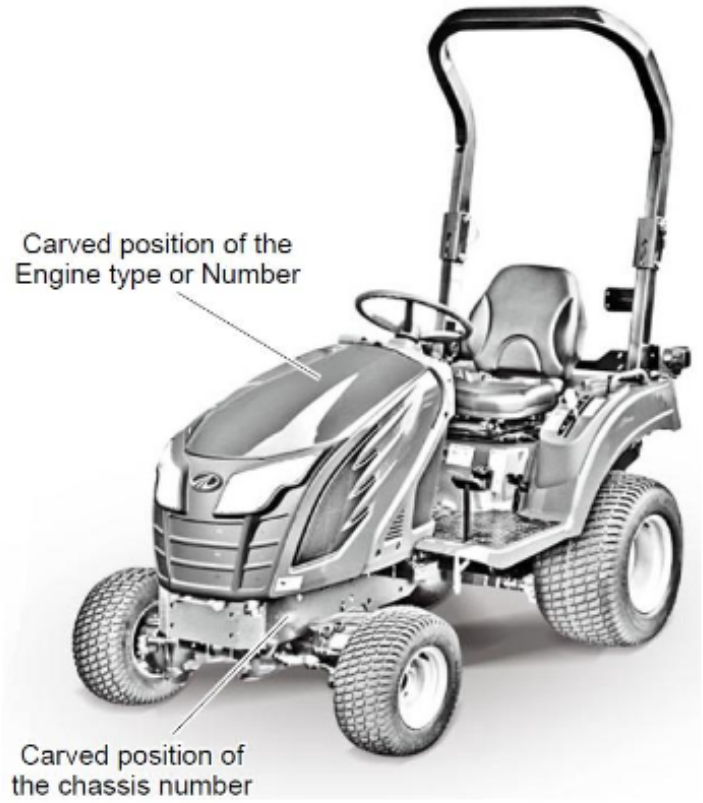
UNIVERSAL SYMBOLS

Some of the universal symbols have been shown below with an indication of their meaning

Engine speed rev/minX100)	Pressured-open slowly	Corrosive substance
 Hours, recorded	Continuous variable	"Tortoise" Slow or minimum Setting
Engine coolant temperature	Warning	"Hare" fast or maximum setting
Fuel level	Hazard warning	Transmission oil pressure
Engine Stop control	Neutral	Turn signal
Lights	Fan	Transmission oil temperature
Horn	Power take off engaged	parking brake
Engine oil pressure	Power take off Disengaged	Head lamp
Air filter	Lift arm/raise	Differential lock
Battery charge	Lift arm/lower	See operator's manual

SECTION 1. TRACTOR TYPES AND PUNCHED IDENTIFICATION MARKS

The tractor serial number is shown on the left hand side of the tractor as shown in the picture. The engine number is stamped on the top of the engine block.



1. MODEL NAME PLATE

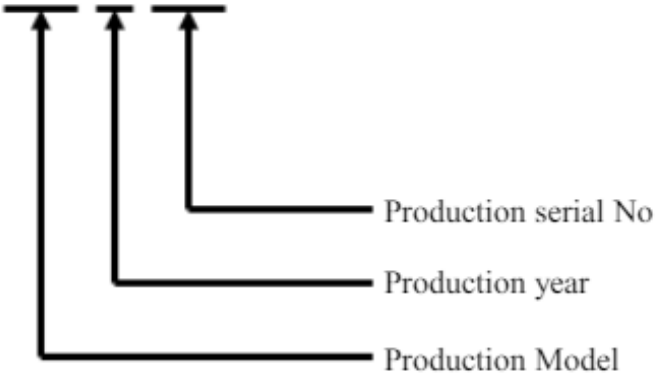
The plate indicates the model and type of the tractor.

① Model name

② Production I.D No.

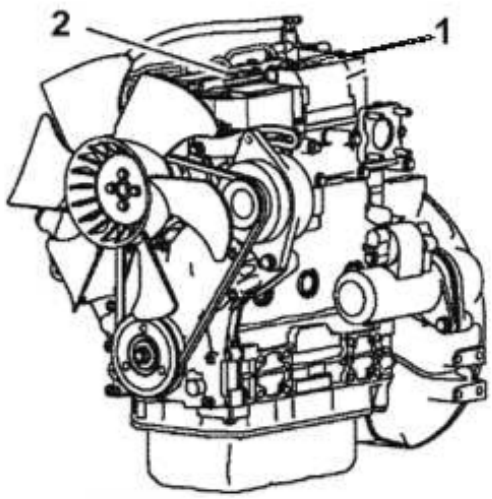
The production I.D reference number is as shown below

19NH L 00001



2. Engine Model Identification and serial number location.

1) Engine identification location (1)



2) Engine EPA decal (2)

This decal represents that this engine is in compliance with the U.S.EPA and California (CARB) exhaust Emission regulation.

Note : The engine number is necessary information that is requisite for the warranty registration form.

Engine number assignment standard

E YDX L 1.267 M 3 N

C YDX L 0.99 M 3 N

- N — Method of air aspiration
- 3 — Number of cylinders
- M — Engine speed specifications
- 0.99 — Displacement (ℓ)
- L — Non-road/off-road engine
- YDX — YANMAR diesel
- C — Model year
  - C: 2012
  - D: 2013
  - E: 2014
  - F: 2015

3) Description of engine model number

Ex) 3 TNV 74F - S DKTF2

3 TNV 80 - 0 0000

- 0000 — Customer code
- 0 — Rated RPM
- 80 — Cylinder bore (mm)
- TNV — Engine series
- 3 — No. of cylinders

Note : When ordering parts or making an inquiry about the engine you are working on, be sure to include the complete model and serial numbers as shown on the engine nameplate.

SECTION 2. SPECIFICATIONS

MODEL		eMax S20 HST
Engine	Maker	YANMAR
	Model	3TNV74F-SDKTF2
	Type	Water cooled 4 cycle, 3 cylinder diesel
	Out put (KW (ps)/rpm)	14.2(19) / 3,000
	Number of Cylinder	3
	Displacement	993 cc
	Bore and Stroke	74 mm x 77mm
	Compression ratio	23.1 : 1
	Firing order	1-3-2
	Rated Speed (rpm)	3,000
	Engine rpm range	1,350 ~ 3235 rpm
	Fuel Injection Pump Type	Indirect Injection
	Lubrication type	Forced circulation
	Engine Oil Capacity (Standard)	2ℓ : 2.8 ~1.5ℓ (0.74~ 0.4US gal)
	Cooling system	Water cooled, Forced circulation
	Coolant capacity	3.5ℓ (0.93 US gal)
	Air cleaner	Dry Single Element
	Muffler	Horizontal
	Fuel	Diesel fuel (Use ultra low)
	Fuel Tank capacity	25ℓ (6.6 US gal)
Electrical	Battery	12V51Ah (45)
	Starting system	Starter motor with pre-heater
	Starter Capacity	12V – 1.0 (1.4)KW
	Alternator	12V - 40Amp
Clutch	Main Clutch	Dry Single Disc, Mechanic (Flange type)
Drive Train	Transmission	Hydraulic + Mechanical H/L with Sliding-mesh
	MFWD(4WD)	Standard
	Differential lock	Bevel gears with diff-Lock
	Brakes	Wet disc brake, mechanical
	Steering	Hydraulic Power
Axle type	Front	Center pin
	Rear	Central axle

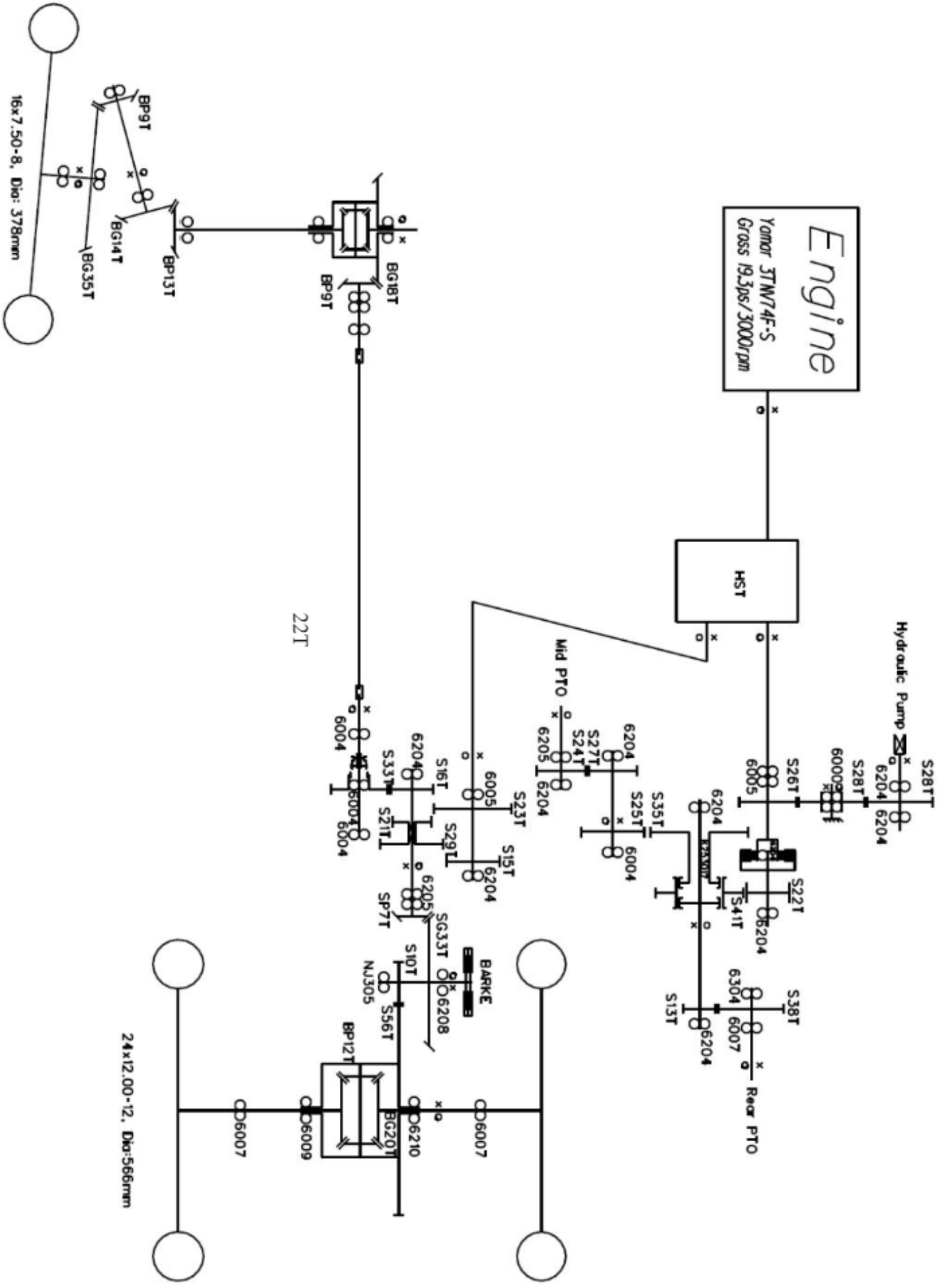
MODEL			eMax S20 HST
Brake	Wet Disc, Foot operated		
	Inner dia.		65 mm(2.5 in.)
	Outer dia.		109 mm(4.3 in.)
	Number of lining		2
	Brake thickness		3.4mm(0.13 in.)
PTO	Type		Independent
	Control		Electro-Hydraulic
	Clutch		Multiple wet Disk
	Rear PTO	Shaft	SAE 1-3/8, 6 spline
		Speed	540rpm@Engine 2,942 rpm
	Mid PTO	Shaft	15 Splines, DP16/32
		Speed	2,500rpm@Engine 2,958rpm
Hydraulics	Control system		SPRING RETURN OPEN CENTER
	Working pressure		130 kgf/cm^2
	Pump capacity(95%)	Main	15.8 LPM (4.17 US gal)
		Steering	8 LPM (2.11 US gal)
3—Point Hitch	Type		SAE Category I (N)
	Control		Position
	Lift Control	At lift points	1,100 lb (499 kg)
		At 24 in behind Lift point	679 lb (308 kg)
Dimensions With R1 Tires	Overall length		2394 mm(94.2 in.)
	Overall Width		1130 mm(44.5 in.)
	Overall height		2200 mm(86.6 in.)
	Wheel base		1350 mm(53.1 in.)
	Min. Ground clearance		210 mm(8.3 in.) at FA
	Weight		650 kg (1433 lb)
Tread	R4	Front	BAR F 16 X 7.50-8PR
		Rear	BAR R 24X12.00-12PR
	R3	Front	TURF F 16X7.50-8PR
		Rear	TURF R 24X12.00-12PR

MODEL			TeMax S20 HST
Tire	R4	Front	BAR F 16 X 7.50-8PR
		Rear	BAR R 24X12.00-12PR
	R3	Front	TURF F 16X7.50-8PR
		Rear	TURF R 24X12.00-12PR

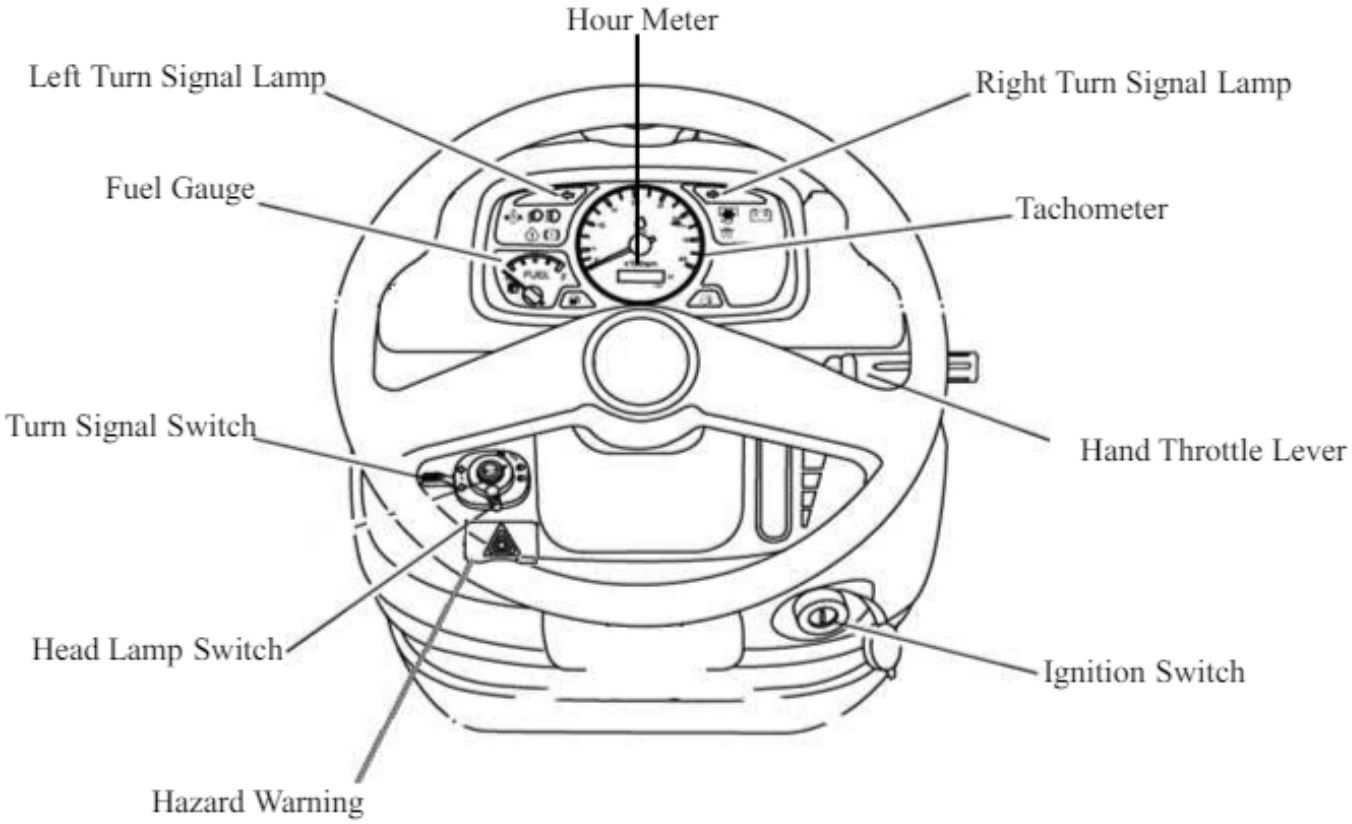
* SPEED CHART (km/h) (Engine Rated Speed : 3000rpm)

	R1	R3
L	6 (4.5 mph)	6 (4.5 mph)
H	12.5 (9.5 mph)	12.5 (9.5 mph)

SECTION 3. GEAR TRAIN DIAGRAMS



1. INSTRUMENTS



Note;

- Oil pressure warning light and charge light on the monitor array will light when the main switch is turned from OFF to ON
- All lights on the panel go out automatically when the engine is started and its speed is increased to a specific level.
- Do not panic if some lights on the monitor light array do not go out while the engine is at idle speed just after its starting. They will go out automatically when the engine speed reaches as a specific level.

MONITOR LIGHT ARRAY

◆ Low beam lamp is operated on the combination switch

◆ PTO Monitor Lamp

This lamp will turn on when PTO clutch is engaged.

◆ Fuel Empty Warning Lamp

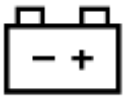
This lamp shows warning that the fuel in fuel tank goes empty.

If this lamp comes on, Fill the tank with fuel.

◆ Oil pressure lamp

This lamp will go out as soon as the engine starts if the oil pressure is correct.

If it comes on while the engine is running, stop the engine and get expert advice.



◆ Charge lamp

This lamp will go off as soon as the engine starts to run to indicate that the alternator is charging (Please note, as broken fan belt can cause the light to come on, please stop the engine as overheating can occur if not rectified immediately).

◆ Glow signal Lamp

This lamp indicates pre-heating.

◆ Turn Signal Lamp

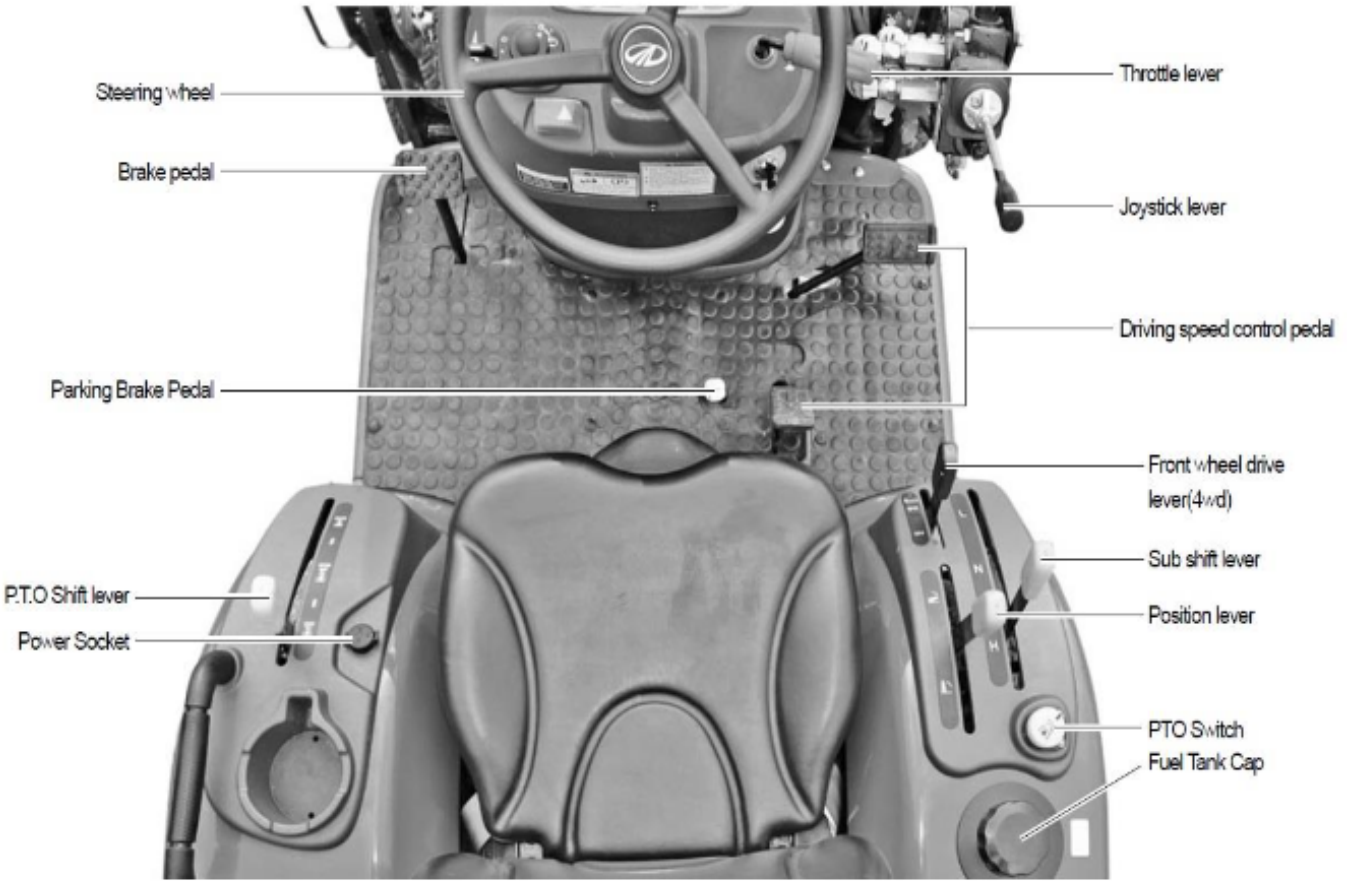
These lamps are used to indicate operator's turn direction.
When indicator is pulled down, left turn signal turns ON and flashes.
When indicator is pushed up, right turn signal turns ON and flashes.
These lamps will turn on and flash when hazard warning switch is pushed.

◆Parking indicator

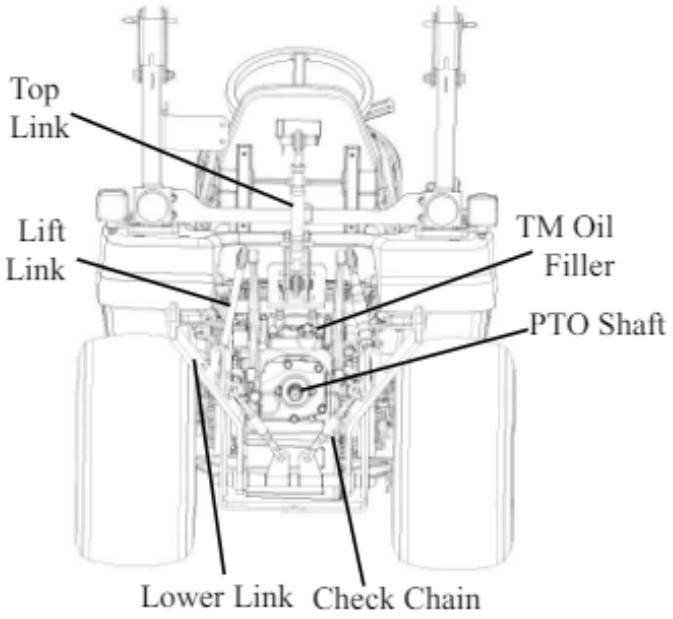
This comes on when the parking brake is applied.

◆Coolant temperature warning lamp

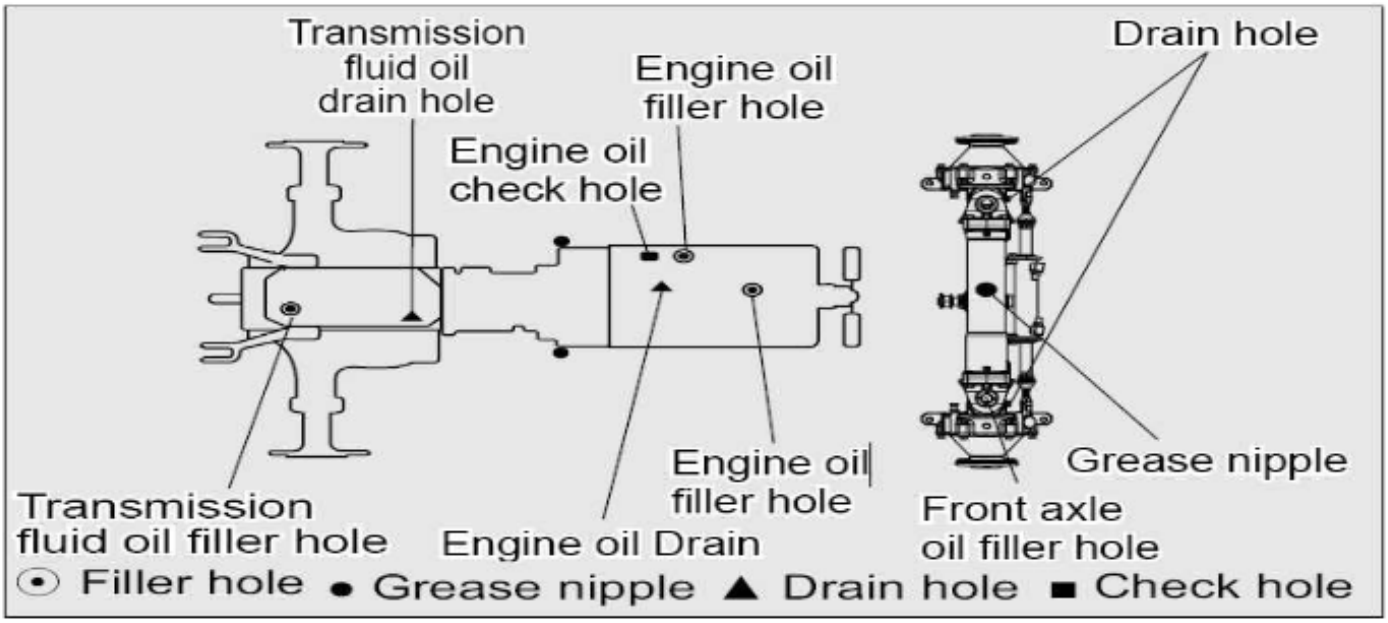
If this lamp comes on, coolant is overheated.



Differential lock pedal



3. FILLING DIAGRAM & CAPACITY TABLE



No.	Filling point	Fillings	Quantity Liter (US gal)
1	RADIATOR	50/50 : Ethylene Glycol/Water (L.L.C) ASTM D4985 / D6210	3.5 ℓ (0.93 US gal)
2	ENGINE	API : Over CF-4 grades Above:25°C(77°F)…SAE30 or 10W-30 0°C to 25°C(32°F to 77°F)…SAE20 or 10W30 Below 0°C(32°F)…SAE 10W or 10W30	2 ℓ (0.53 US gal)
3	TRANSMISSION CASE	(API GL-4 Grades)Gear oil #80 or #90 TYM Standard : THF 500	14ℓ (3.7 US gal)
4	FRONT AXLE		2.6ℓ (0.7US gal)
5	BRAKE PEDAL SHAFT	Lubricant / Grease	As required
6	FRONT AXLE PIN		
7	FUEL TANK	Diesel fuel specification : ASTM D975, EN590:96, ISO 8217 DMX JIS K2204 Grade No. 2, GB252, KSM-2610	25ℓ (6.6 US gal)

Tire size and inflation

Tire	DIVISION	Type	Inflation	MODEL
R4	Front	BAR F 16 X 7.50-8PR	28psi (1.9 kg/cm2)	**eMax S20 HST**
	Rear	BAR R 24X12.00-12PR	20psi (1.4 kg/cm2)	
R3	Front	TURF F 16X7.50-8PR	24psi (1.6 kg/cm2)	
	Rear	TURF R 24X12.00-12PR	20psi (1.4 kg/cm2)	

4. MAINTENANCE CHART

○ Inspection, Replenish, and Adjustment

● Replacement △ Cleaning and/or washing

★ Consult your Dealer

Periodical check and service table

☞ **ENGINE**

Inspection items	Daily	Inspection and servicing intervals Hour of operation (X10 on hour meter)												Intervals after that	Judgment criteria mm(in)
		5	10	15	20	25	30	35	40	45	50	55	60		
Engine oil	○	●					●					●		Replace after every 250hours or 12months after first 50 hours	Level is between upper and lower limits
Oil filter		●					●					●			
Air cleaner			△		△		△		△		△		●	Clean after every 100hrs.Replace element that has been cleaned more than 5 times	Replace it damaged or every year
Radiator coolant	○													Replace every year or every 1000 hrs. Check daily to up if required	Fill coolant up to radiator throat
Radiator	○													Check daily for damages leakage	
Radiator fin & screen	○				△				△				△	Clean everyday and before work	Clean cooling fins and cores
Fuel	○													Everyday and before work	Tank should be full
Fuel filter Water separation	○		○	△	○	△	●	○	△	○	△	○	●	Wash after every 100hrs.and replace after 300 hrs or 12 months	Check water separation before work
Fan belt	○														About 7mm(0.27in) deflection pushed with a finger
Hose clamps	○														Tighten if required
Loose nuts and bolts	○													Check daily	Tighten
Electrolyte level	○		○		○		○		○		○		○	Check after every 100hrs.and replenish if necessary	

○ Inspection, Replenish, and Adjustment

● Replacement △ Cleaning and/or washing

★ Consult your Dealer

☞ TRANSMISSION

Inspection items	Daily	Inspection and servicing intervals Hour of operation (X10 on hour meter)												Intervals after that	Judgment criteria mm(in)
		5	10	15	20	25	30	35	40	45	50	55	60		
Transmission oil	○	●					★					●		Every 500 hours or 12months after first 50 hours	Clean hydraulic suction filter at the same time.
Brake pedal free play	○													Check daily	Free Play:30 to 40mm
Brake performance	○													Check daily	Interlocked brakes should work simultaneously
Lever performance	○													Check daily	Every lever should work positively
Steering wheel free play	○													Check daily	About 50mm (1.97) on circumstance
Toe-in							★						★	Check after every 300 hrs	2 to 6mm (0.078 ~ 0.236 in)
Retightening ball joints of steering system	○						○						○	Check after every 300 hrs	
Grease in front axle hinge pin							○						○	Grease every 300 hrs	
Grease each nipple		○	○	○	○	○	○	○	○	○	○	○	○	Replenish every 50 hrs (Everyday in dusty condition)	
Wheel tightening bolts and nuts	○													Check daily F (9/16-18UNF) R (1/2-20UNF) SAE J429 Grade 5	All should be tighten (lb.ft / kgf.cm) Front : 121 / 1660 Rear : 84.9 / 1167
Loose bolts and nuts	○														All should be tighten
Electric wiring	○						○						○	Check every year	All should work properly.

○ Inspection, Replenish, and Adjustment

● Replacement △ Cleaning and/or washing

★ Consult your Dealer

Inspection items	Daily	Inspection and servicing intervals Hour of operation (X10 on hour meter)												Intervals after that	Judgment criteria mm(in)
		5	10	15	20	25	30	35	40	45	50	55	60		
Operation of the instrument	○													Check daily	
Electric apparatuses														Check every year	All should work properly
Adjusting throttle lever							★					★		Check after 300 hours	
Hydraulic fluid strainer		△				△				△				Clean after every 200 hours or 12months after first 50 hours	Replace if necessary
HST oil Filter		●					★					●		Replace after every 200 hours or 12months after first 50 hours	
4WD front axle housing oil		●		○		○	★	○		○		●		Check after every 100 hrs. Replace every 500hrs after first 50hrs	Replace if leaking
Rubber pipes		○		○		○		○		○		○		Check after every 100 hrs.	

1) Every terminal should be connected securely

2) Wiring should not interfere with other parts.

3) Fatigued wiring should be replaced.

4) Wiring should be held in each clamp properly.

Chapter 2

Disassembly and reassembly of major components

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7. Separation of the transmission and rear axle housing ---------- 2-17

Chapter 2

Disassembly and reassembly of major components

SECTION 1. GENERAL PRECAUTIONS FOR SEPARATION AND REINSTALLATION

1. BEFORE OPERATION

1) Always be safety-conscious in selecting clothes to wear and suitable tools to use.

2) Before disassembly, be sure that you familiarize yourself with the assembled condition for subsequence in reassembly.

3) Keep parts and tools in proper order during operations.

4) When servicing electrically charged parts, be sure to disconnect the negative battery terminal.

5) To prevent oil or water leaks, use the liquid gasket as required.

6) When lifting up only the front or rear part of the tractor, be sure to wedge the grounded wheels.

8) When the tractor is jacked up, be sure to support the entire tractor with something like a stand. Lifting it up with a jack only is dangerously unstable procedure.

9) When replacing parts, use authorized, genuine TYM parts only. TYM assumes no responsibility for accidents, operating problems or damage caused by the use of imitation parts.

Also the use of unauthorized parts will result in relatively poor machine performance.

2. PRECAUTIONS TO BE FOLLOWED WHEN INSTALLING STANDARDIZED PARTS.

(1) Roller or Ball bearings

1) When a bearing is fitted in by the outer race, use an installer which is an specially designed to push only the outer race and vice versa.

2) The installer must be designed to install the bearing on the shaft in a parallel position.

3) When installing a bearing which appears the same on both sides, install it so that the face which has the identification number faces in a direction for easy visual identification. All the bearings which are to be installed in the transmission case should be placed so that their identification number faces outward.

4) If a shaft or hole where a bearing is to be installed has a stopper, the bearing should be pushed in completely until it is seated against the stopper.

5) Installed bearings should turn smoothly.

(2) Oil seals

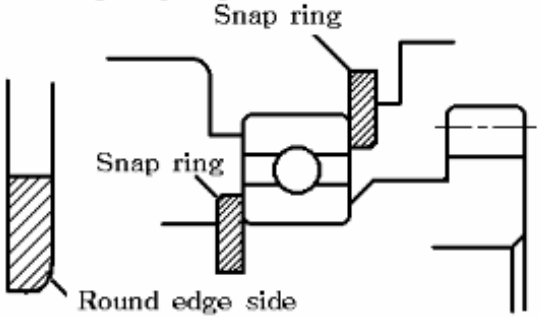
1) Oil seals installer should be designed so as not to deform the oil seals.
2) During installation, be careful not to damage the lips, and assure that it is pushed in parallel to the shaft or hole.
3) When oil seals are installed, there should be no turnover of the lips nor dislocation of the springs.
4) When a multi-lip seal is installed, the grooves between lips should be filed with grease, not adhesive.

(3) O-rings

1) O-rings should be coated with grease before installing.
2) Installed O-rings should have no slack or twist.
3) Installed O-rings should maintain proper air tightness.

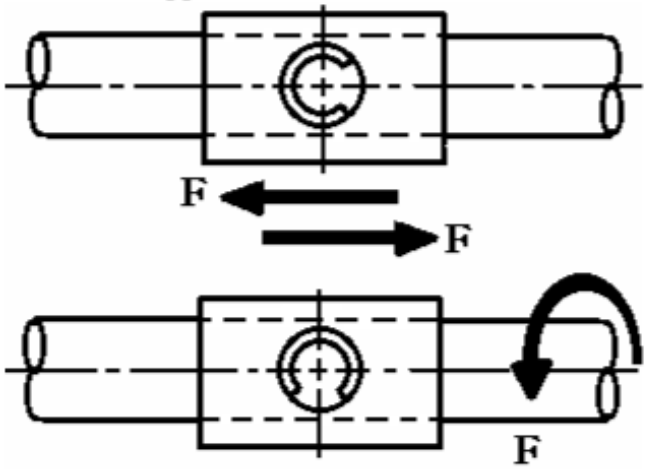
(4) Snap rings

1) Snap ring installers should be designed so as not to permanently deform the snap rings.
2) Installed snap rings should be seated securely in the groove.
3) Be careful not to overload the snap ring to the extent that it is permanently deformed.
4) How to install the snap ring:
   When installing a snap ring, install it as shown in the figure with its round edge side turned toward the part to be retained. This round edge is formed when the snap ring is pressed out.



(5) Spring (roll) pins

1) Spring pins should be driven in properly as tightly.
2) Spring pins should be installed so that they seams should face the direction from which the load is applied.



3) The roll pins installed in the transmission or other parts where much force is applied should be retained with the wire.

(6) Cotter pins

When installed, cotter pins should be bent securely at the ends as shown in the figure

(7) Bolts and nuts

1)Special bolts are installed at several locations, so be sure not to interchange them other bolts.
2) Bolts and nuts should be tightened to their specified torque wrench.
3) When locking the bolts or nuts with wire or a lock washer, Be sure to wind the wire paying sufficient attention to its winding direction and bend the lock washer for secure looking.
4) When locking bolts and nuts with an adhesive, apply the adhesive on the thread and tighten securely.
5) Apply an adhesive (THREE BOND TB1104) to parts through which there is any possibility of oil leaks, such as stud bolts and tapped-through parts.
6) Each lock nut must be tightened securely.
7) When tightening bolts and nuts, refer to the tightening torque table.

(8) After installation, each grease fitting should be filled with grease.

1) When installing grease fittings of type B and C, be sure to turn the fitting tips in a direction that will provide easy access for a grease gun.

(9) Other precautions.

1) Be sure not to damage any finished surfaces or parts.
2) Always refrain from forcing installation.
3) Each lever knob should be installed coated with an adhesive
   (SUPER THREE CEMENT TB1702)

4) Each contact surface should be coated with an adhesive (THREE BOND TB 1215) and tightened evenly with bolts. Adhesive coated surfaces should be installed within 30 minutes after application of the adhesive. The contact surfaces should be flawless and free from foreign matter, and especially from grease before application of the adhesive.

5) Precautions for applying adhesives.
The surface or the thread where and adhesive is to applied should be completely free of chips. The surface or the thread where an adhesive is to be applied should be completely free of oil-less.

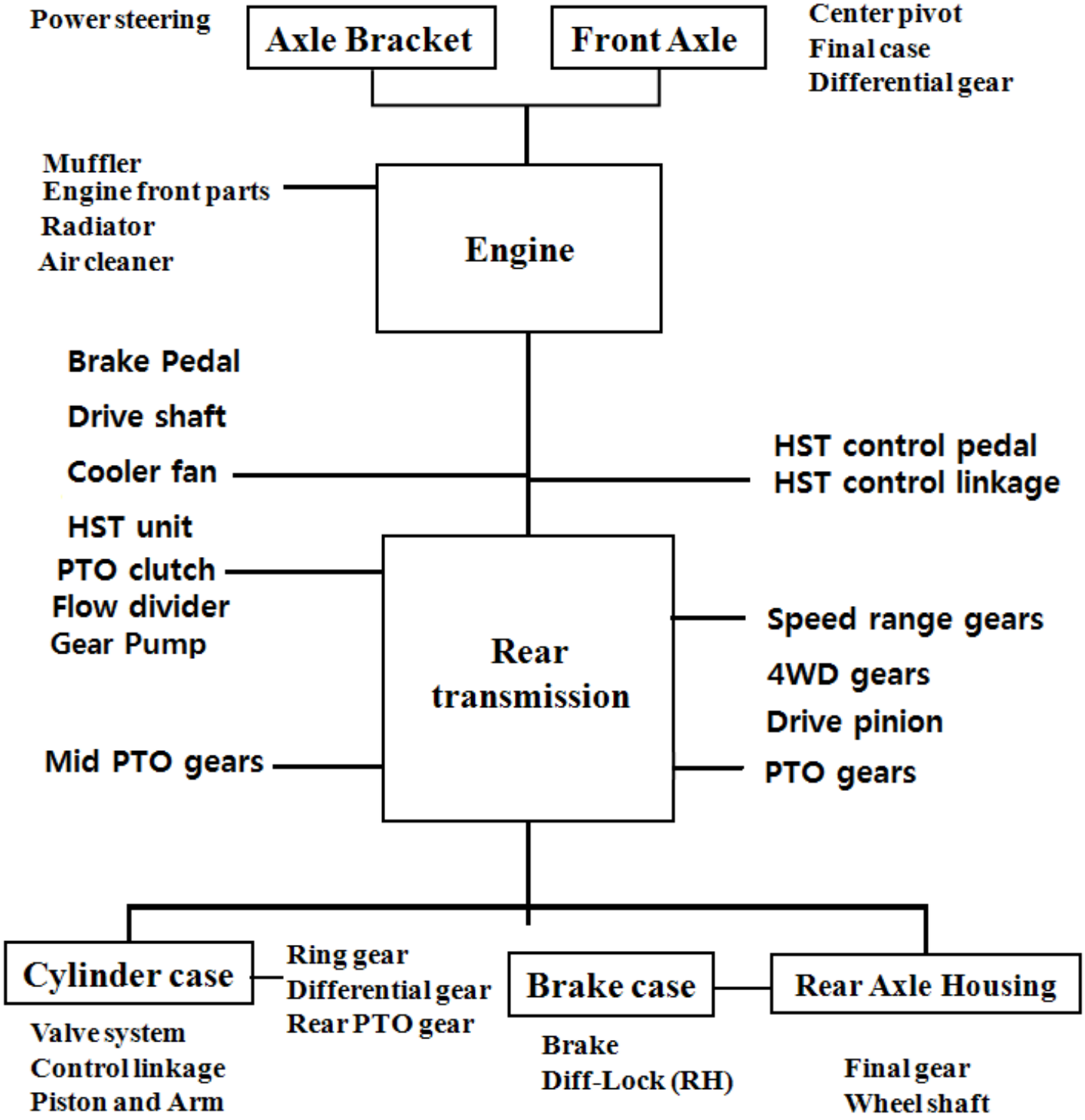
Bolt Tightening Torque (kgf.m) (= 7.23 lb/ft =9.8N.m)						
Spec	4T		7T		9T	
	Coarse	Fine	Coarse	Fine	Coarse	Fine
M3	0.07~0.09	-	-	-	-	-
M5	0.35~0.45	-	0.5~0.7	-	-	-
M6	0.50~0.70	-	1.1~1.4	-	1.25~1.45	-
M8	1.3~1.7	-	2.3~3.0	-	3.0~3.5	-
M10	2.5~3.5	2.0~2.8	4.5~6.0	3.6~4.8	6.5~7.2	5.2~5.76
M12	4.5~6.0	3.6~4.8	8.0~10	6.4~8.0	10.5~12	8.4~9.6
M14	7.0~8.5	5.6~6.8	12~15	9.2~12	17~20	13.6~16.0
M16	11~14	8.8~11.2	17~21	13.6~16.8	20.5~31	16.4~24.8
M18	16~19	12.8~15.2	24~29	19.2~23.2	35~41	28~32.8
M20	22~27	17.6~21.6	33~41	25.4~32.8	50~58	40~46.4
* In case of nut torque, 80% torque of above table respectively						

Air-conditioner (kgf.m)			
R-12 (R-134a)	Pipe Diam.	Without O-ring	With O-ring
7/16-20UNF (-)	1/4",D6	1-1.5	-
9/16-18UNF (M16xP1.5)	5/6",D8	2-3	1-2
5/8-18UNF (M18xP1.5)	3/8",D9.52	2-3	1-2
3/4-16UNF (M20xP1.5)	1/2", D12.7	3-4	1.5-2.5
7/8-14UNF (M22xP1.5)	5/8",D15.8	4-5	2-3
11/16-14UNF (-)	3/4",D18.9	5-6	2.5-3.5
11/14-12UNF (-)	7/8",D22.2	6-7.5	3-4

Coupling-Hydraulic (Kgf-m)	
¼"	2.5
3/8"	5
½"	6
¾"	12
1"	14
1-1/4"	17
1-1/2"	21

Nut-Bearing (kgf.m) (Calking Nut only)										
AN02	AN03	AN04	AN05	AN06	AN07	AN08	AN09	AN10	AN11	AN12
M15	M17	M20	M25	M30	M35	M40	M45	M50	M55	M60
2 - 4	2 - 4	3 - 5	3 - 5	3 - 5	6 - 8	6 - 8	6 - 8	8-10	8-10	8-10

SECTION 2. OPERATION CHART FOR DISASSEMBLY AND REASSEMBLY BY MAJOR BLOCKS



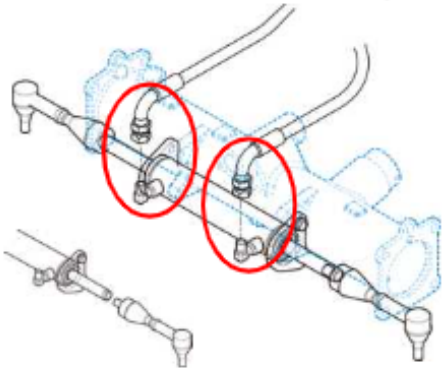
SECTION 3. SEPARATION OF MAJOR COMPONENTS

1. SEPARATION OF THE FRONT AXLE AND AXLE BRACKET

Parts which can be inspected during this operation
-Center pin
-Final case
-Differential gear
-Power steering cylinder

(1) Removal

1) Hold the front hitch or the front bracket securely with a crane or stands.
2) Support the front axle with a jack
3) Remove both right-hand and left-hand steering hose.
4) Remove the split pin and nut and link pin.
5) Remove the front axle assembly forward.



Note :
When the pipes of hydraulic system are removed, their openings should be covered with plastic caps or the like to keep out dust or other foreign matter.

FIG.2-1 steering hose and tie rods

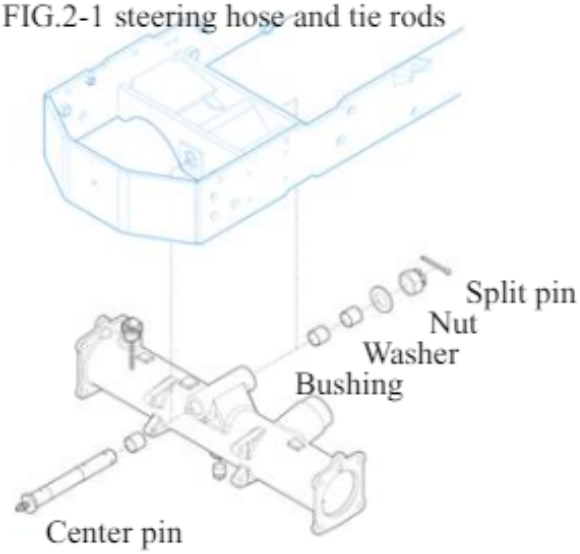


FIG.2-2 Front axle

Note:
When working on the 4WD version, the drive shaft should be removed ahead of time.

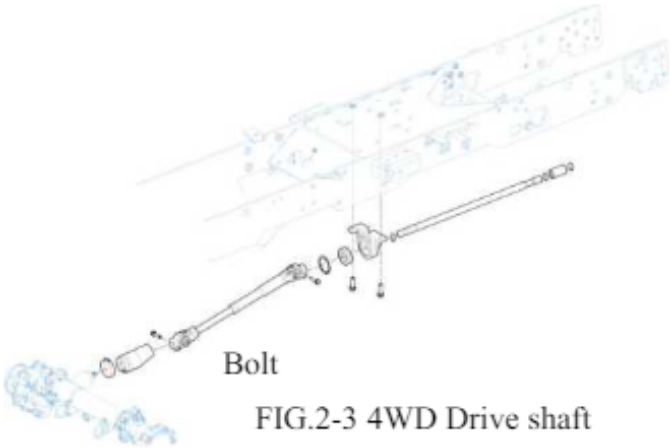


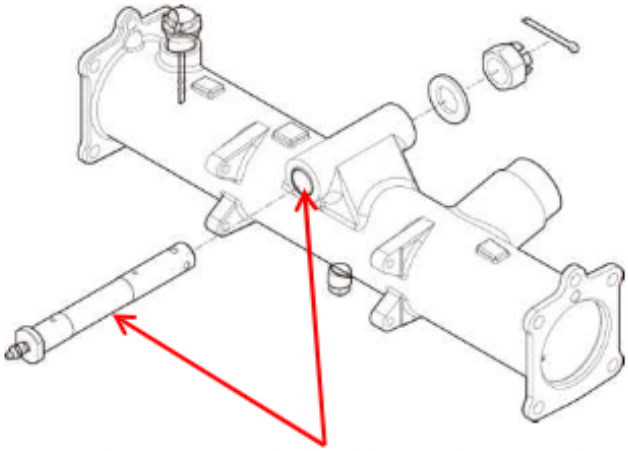
FIG.2-3 4WD Drive shaft

(2) Installation

1) Install the front axle assembly.
2) Install the center pin and nut and split pin.
3) Install both steering hoses (LH / RH).
4) Install the 4WD drive shaft after applying the adhesive (TB1901) on the splines.

Note : Clean the center pin and bushing around. Apply grease to the bushing and the center pin with grease ahead of time.

Install the bushing carefully not to allow scratch on inside of bushing.



Apply grease to the bushing and center pin

Note : Inject the multi-purpose grease through the grease nipple enough.

FIG.2-4 Center pin (Support)

Tightening torque	
M12x1.75-40L (9T)	15 ~ 26 Kgf.m (108 ~ 188lb.fts)

2. SEPARATION OF THE ENGINE AND THE FRONT AXLE BRACKET

Parts which can be inspected during This operation
-Engine assembly
-Air cleaner -Radiator -Muffler -Fuel filter
-Engine front part
-Drive shaft -Fuel tank

(1) Removal

1) Hold or support the engine with a crane or stands.
2) Hold or support the front axle bracket in a manner that the part other than the engine can be removed if required.
3) Open the hood by pulling the latch.
Remove the side cover (LH / RH).

FIG.2-5 Hood latch

FIG.2-6 Head Light Harness

4) Disconnect the engine harness from the alternator, starter motor, water temperature sensor, oil pressure.

FIG.2-7 Starter motor/Alternator

5) Remove the accelerator cable.
Disconnect the engine stop solenoid wiring.

FIG.2-8 Accelerator cable/Wiring

6) Remove the fuel hoses and filter assembly.

FIG.2-9 Fuel hoses

7) Remove the air cleaner inlet pipe.
Remove the inlet/outlet pipes from radiator.

FIG.2-10 Air cleaner assembly

Note : The radiator should be drained of the coolant ahead of time.

8) Remove the nuts which is tightened to engine.

FIG.2-11 Mounting bolts

Note : It is better for the lower nuts of mounting rubbers to be removed completely and the upper nuts should be removed slightly in order to reassemble the engine easily.

9) Lift up the engine assembly with the hoist.

FIG.2-12 Engine hook

Note : Lift up the cabin gradually making sure that all relevant wiring, clamps are disconnected. And be careful not to interfere with each other.

10) Remove the drive shaft from engine.

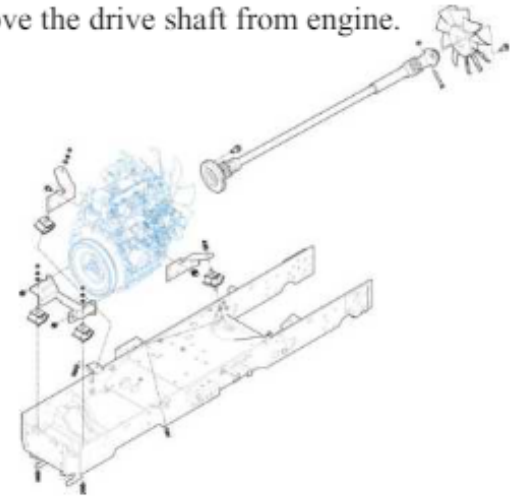


FIG.2-13 Drive shaft

(2) Installation

Reassemble in reverse order of removal.

1) Loosen the nuts slightly which are mounted to the engine.
2) The engine is seated to the mounting rubbers.
3) Install the drive shaft to engine.
4) Tighten the nuts.

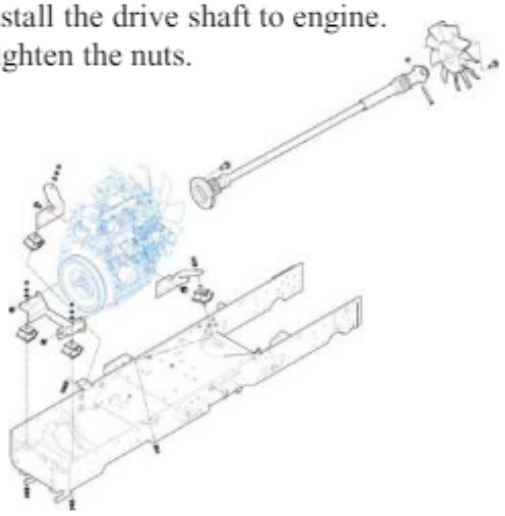


FIG.2-14 Drive shaft

5) Install the pipes for radiator.
6) Install the pipe of air cleaner.
7) Connect the wiring harness.
8) Install the accelerator cable.
9) Install the side covers.

3. SEPARATION OF THE FUEL TANK AND THE FRAME COMPONENT.

Parts which can be inspected during this operation.
-Fuel tank

(1) Removal

1) Drain the diesel fuel into the fuel tank.
2) Remove the seat assembly.

FIG.2-15

3) Remove the pipe A.
Remove the plate B and C.

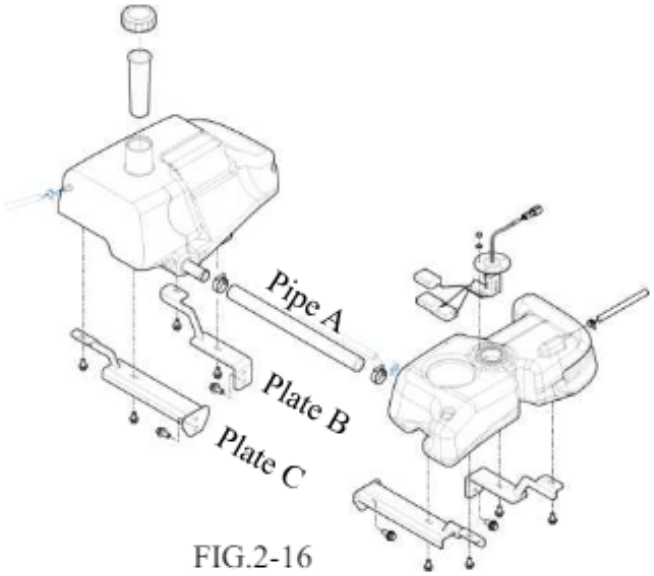


FIG.2-16

Note : Remove the rear tires if necessary.
Disconnect the wiring of fuel gauge.
Remove the fuel thank cap.

(2) Installation

Reassemble in reverse order of removal.

Note : Be careful not to be damaged interfering with each other.

4. SEPARATION OF THE FRONT AXLE BRACKET AND THE TRANSMISSION

Parts which can be inspected during This operation
- HST unit and pedal linkage
- Brake pedal and linkage

(1) Removal

1) Drain the oil into the transmission case. (3.7 gal / 14 Liter)
2) Wedge both sides of the front axle to prevent the engine from tilting.
3) Remove the seat assembly and the floor mat and floor panel.

Note : It is possible to remove the floor panel with mat together.

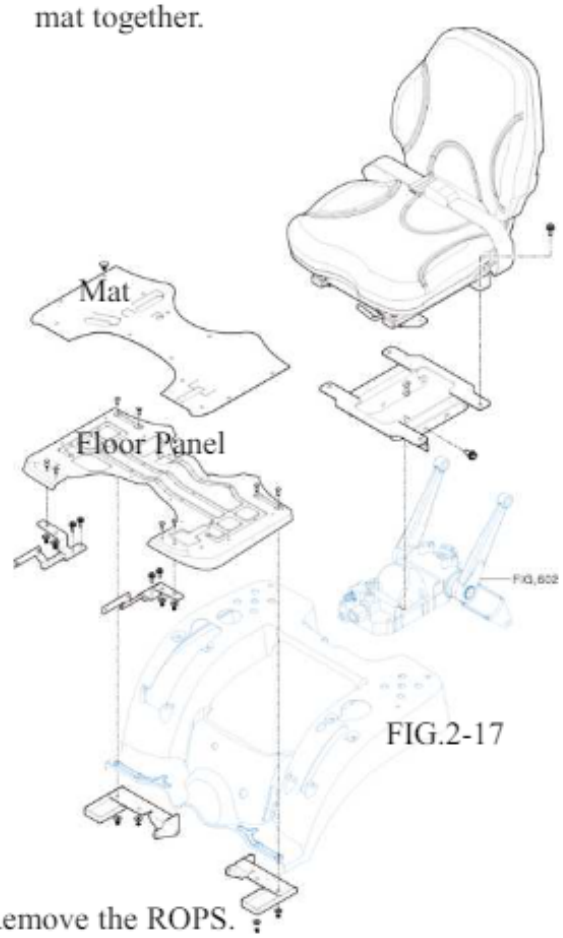


FIG.2-17

4) Remove the ROPS.
Remove the bolts which are tightened to 3P hitch.

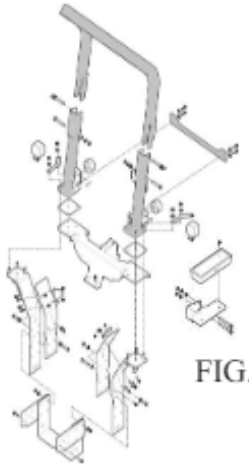


FIG.2-18

3 P hitch

5) Remove the floor panel seat.
The wiring of PTO is disconnected.

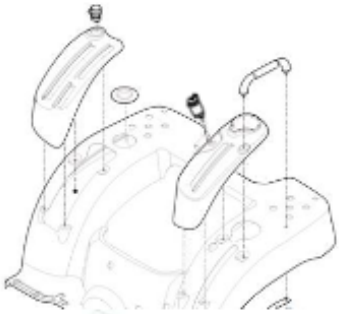


FIG.2-19

6) Disconnect the wirings between the engine harness and the rear harness.

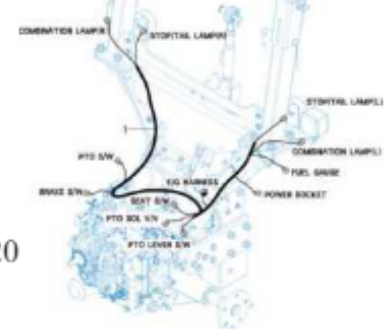


FIG.2-20

7) Remove the hydraulic pipes and gear pump.
Remove the bracket of valve.

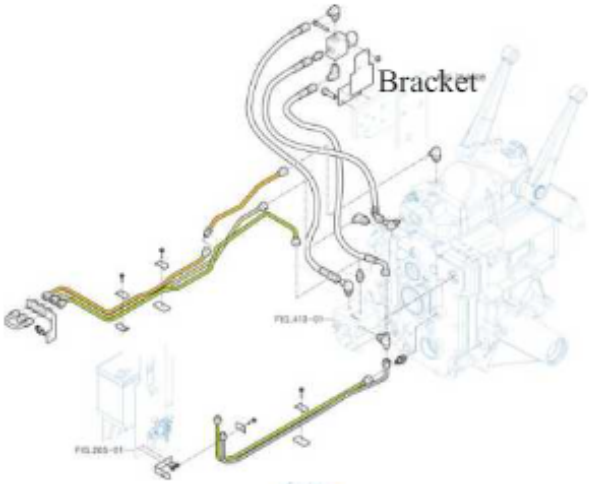
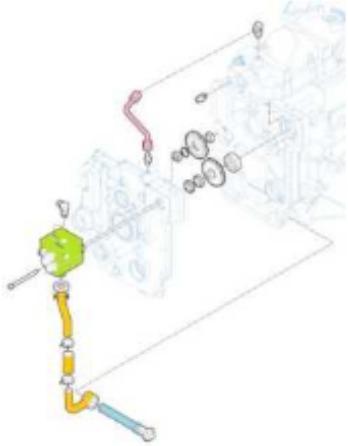


FIG.2-21



7) Remove the drive shaft.
Remove the brake rod and the spring.
Remove the neutral lever comp and the spring.
Remove the control plate.
Remove the fuel hoses.

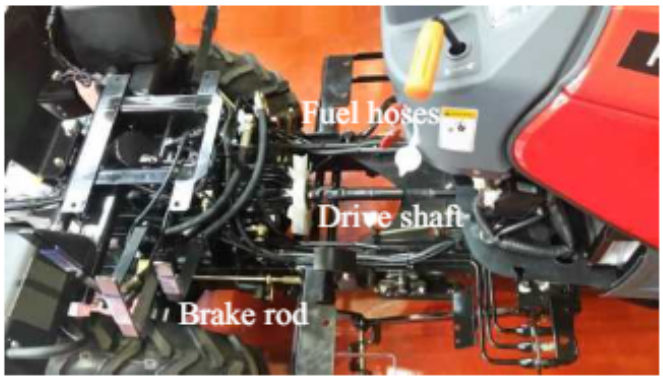
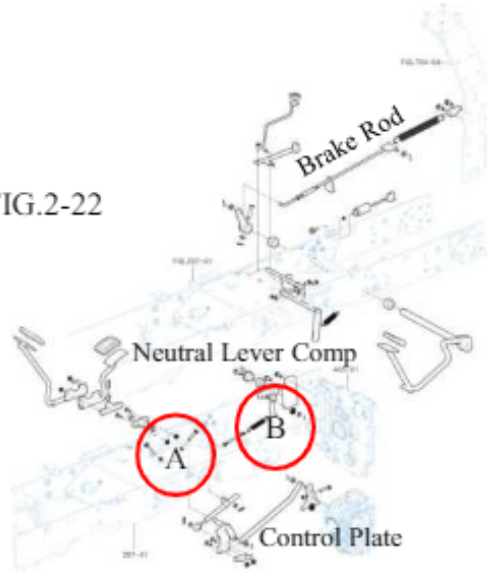


FIG.2-22



8) Remove the link B comp.

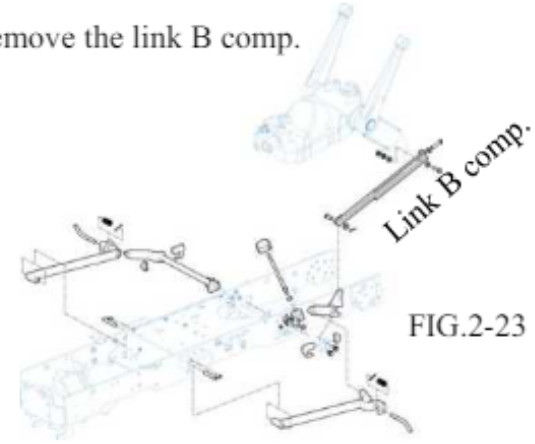


FIG.2-23

Note : Hold or support the front axle bracket with a crane or stands.
Hold or support the transmission assembly with a crane or stands.

Note : Wedge both sides of front axle assembly to prevent the engine from tilting.

9) Remove the bolts which are tightened to front axle bracket.

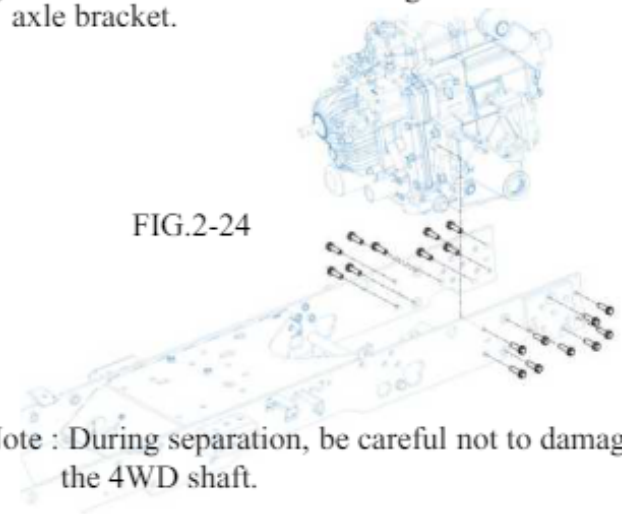


FIG.2-24

Note : During separation, be careful not to damage the 4WD shaft.

(2) Installation

Reassemble in reverse order of removal.

1) During reassembly, make sure the splines stay aligned (4WD Shaft). Apply a thin coat of molybdenum grease(TB1901) to the splines prior to reassembly.
2) Tighten the bolts between the transmission case and the front axle bracket to specified torque. Apply the adhesive(TB1401) on the threads of bolts when installed to transmission case (10 EA).

Tightening torque (Part A of Fig 2-24)	
M12x1.75-40L (9T)	6 ~ 6.5 Kgf.m (43 ~ 47lb.fts)

3) Install the link B comp.
4) Install the brake rod and the drive shaft.
5) Install the fuel hoses.
6) Install the neutral lever comp and control plate.
a. Adjust the location of pedals in A part of Fig2-22.

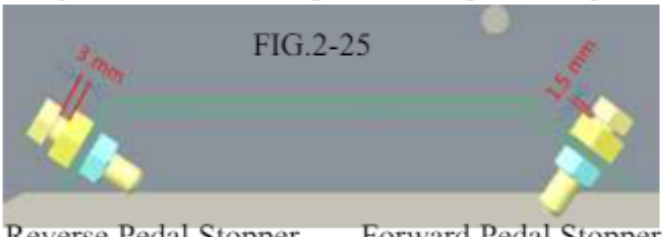


FIG.2-25

Reverse Pedal Stopper Forward Pedal Stopper

b. Adjust the tension of spring in B part of Fig2-22.

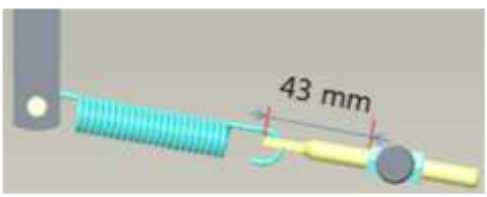


FIG.2-26

c. Install the brake rod.

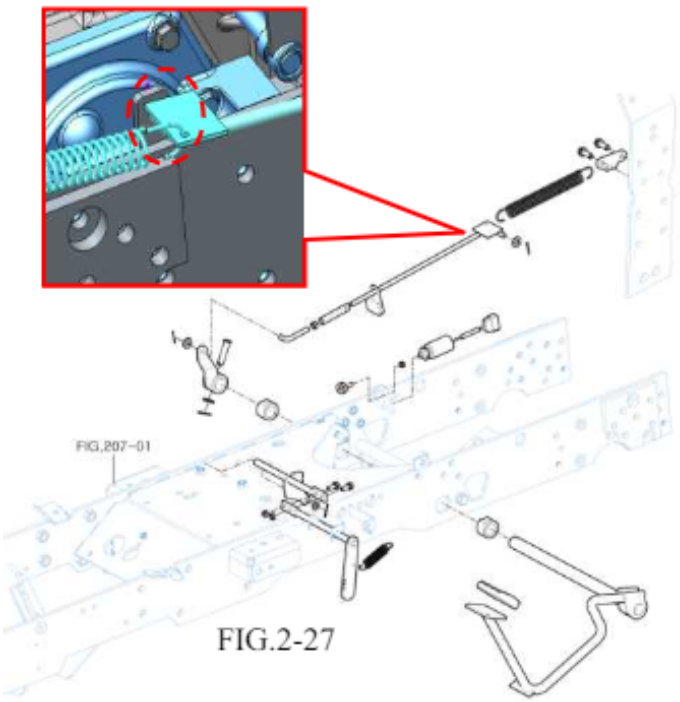


FIG.2-27

7) Install the hydraulic pipes.
   Install the bracket of valve.

8) Connect the wirings.

9) Install the floor panel seat.

10)Install the ROPS.

11)Remove the wedges.

12)Fill the fuel tank with diesel.

13)Fill the transmission with the oil.

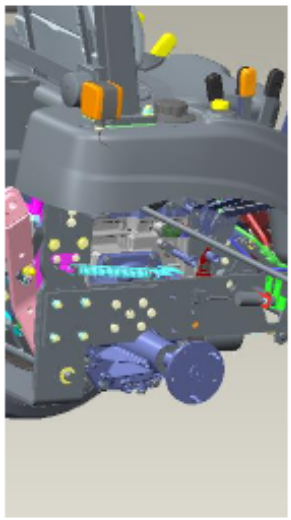
(3) How to set the Neutral position for HST unit

If tractor moves forward or reverse without F/R pedal operation, follow below procedures.

1) Park the machine on the level ground.
2) Hold the front axle bracket and rear axle security with a crane or hoist.
3) Support the front axle and the rear axle with a jack to float it in the sky
4) Wedge both sides of the front axle to prevent the engine from tilting.
5) Disengage the 4 WD shifting system.
6) Remove the rear right tire from the tractor.
7) Turn the ignition switch to start the engine.
8) Engage the "HI" speed by the range shift lever.
9) Put the accelerator lever at the maximum speed and check the rotation direction of rear axle.
10) In case of rotating to forward
10-1. loosen the locking screw slightly.
10-2. Turn the neutral lever towards backward a little. (Counter Clock Wise).
10-3. Tighten the locking screw completely if it does not move when F/R pedal is pressed.
10-4. Press the speed control pedal to "Reverse", and then press the "Forward" pedal. Repeat the F/R pedal three times.
10-5. Check the rear axle to stop the rotating.

11) In case of rotating to reverse
11-1. loosen the locking screw slightly.
11-2. Turn the neutral lever towards forward a little. (Clock Wise).
11-3. Tighten the locking screw completely if it does not move when F/R pedal is pressed.
11-4. Press the speed control pedal to "Forward", and then press the "Reverse" pedal. Repeat the F/R pedal three times.
11-5. Check the rear axle to stop the rotating.

4 WD Shifting Lever



Removal of Rear tire (RH)

FIG.2-28

(4) How to check and adjust the neutral inspection for the dynamic braking test.

If the pedal is too slow in returning to "Neutral" position when releasing the foot from the pedal, adjust the HST neutral spring.

Since the speed can be adjusted by the HST neutral Spring, when the HST neutral spring tension is weakened, the spring tension should be checked and adjusted every 100 hours.

Dynamic braking test ;

1) Start the engine and it needs to warm the engine up to 50 ℃ of oil temperature
2) Operate the machine on the level ground.
3) Engage the range shifting lever to "HI" position. And put the accelerator lever to maximum speed.
4) Press the speed control pedal to "Forward"
5) Release the foot from the speed control pedal.
6) Measure the distance between releasing foot and the stop point of machine.
7) If the distance is more than approximately 3m, strengthen the HST neutral spring tension so that the machine can be stopped in approximately 3m.

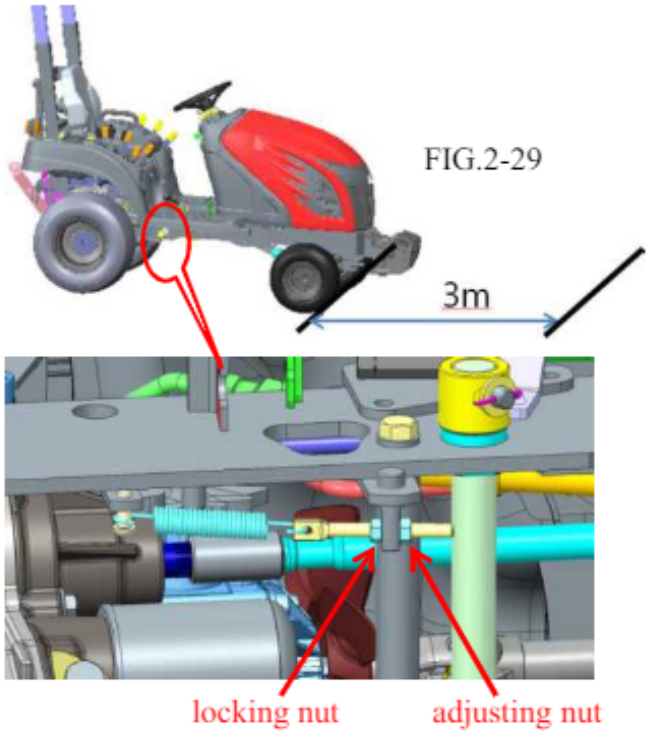


FIG.2-29

8) If the machine is not stopped with dynamic brake within approximately 3m, adjust the neutral spring to be tightened.

Note : It is possible to adjust the trajectory of damper force by moving the arm position.

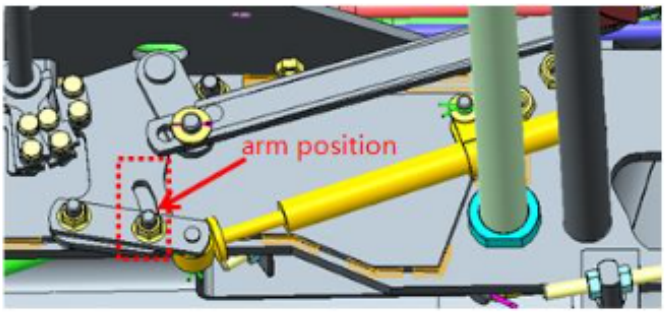


FIG.2-30

5. SEPARATION OF THE EXTERIOR COMPONENT AND THE TRANSMISSION

Parts which can be inspected during This operation
- Floor panel assembly
- Seat assembly
- Drive shaft
- Grips
- Hydraulic valve and pipes

(1) Removal

Note : Be careful not to make scratch on the surface of the plate when removed and reassembled.

1) Detach the grips.

FIG.2-31 Grip of control

2) Remove the seat assembly.
Remove the mat and floor panel.

FIG.2-32 Floor panel & seat

3) Remove the ROPS.

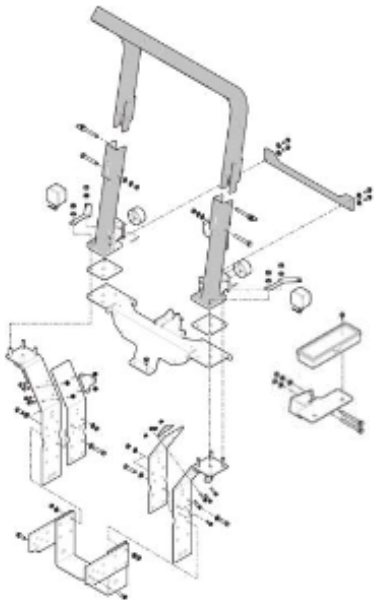


FIG.2-33 ROPS

4) Remove the lever cover (LH, RH).
Remove the fender assembly.

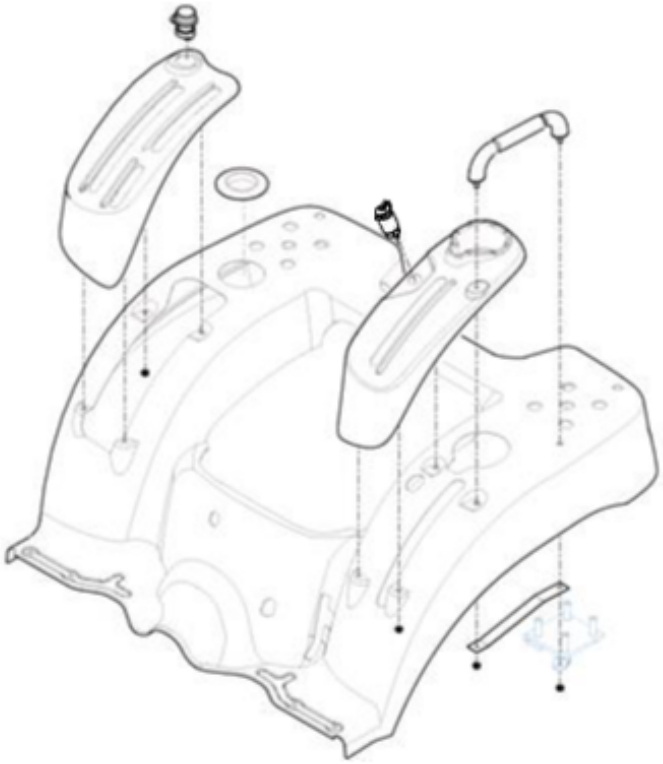


FIG.2-34 Fender

5) Remove the fuel tank (LH, RH).
Remove the rear wiring harness.

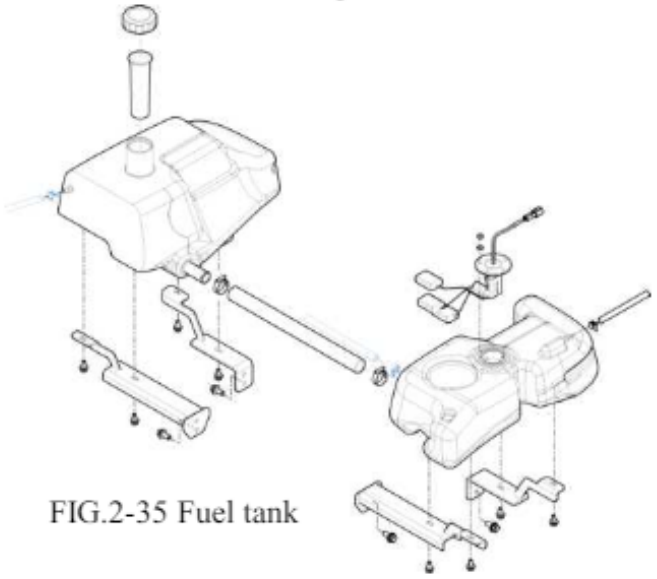


FIG.2-35 Fuel tank

6) Remove the Mid frame comp.
Remove the frame comp (LH/RH) and the hitch frame comp. together.

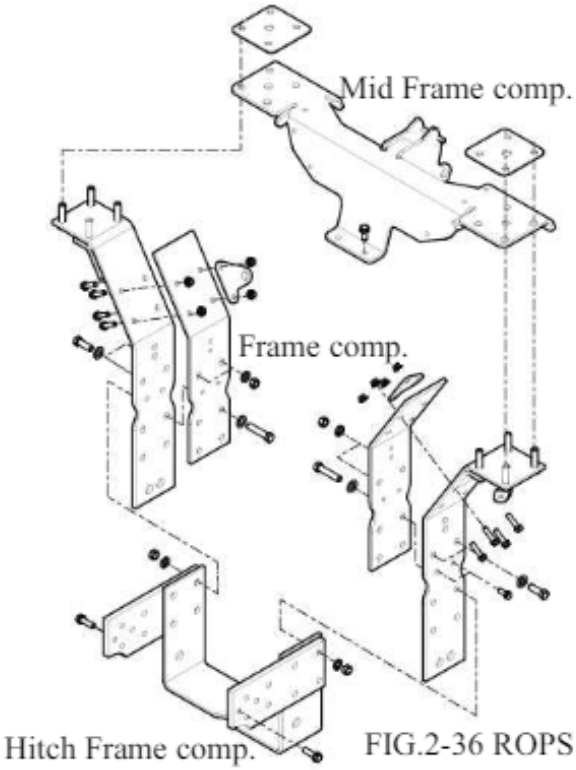


FIG.2-36 ROPS

Note : When the three point hitch is equipped, it is possible to remove hitch frame comp. together.

7) Remove the cover comp. after loosening the bolts..

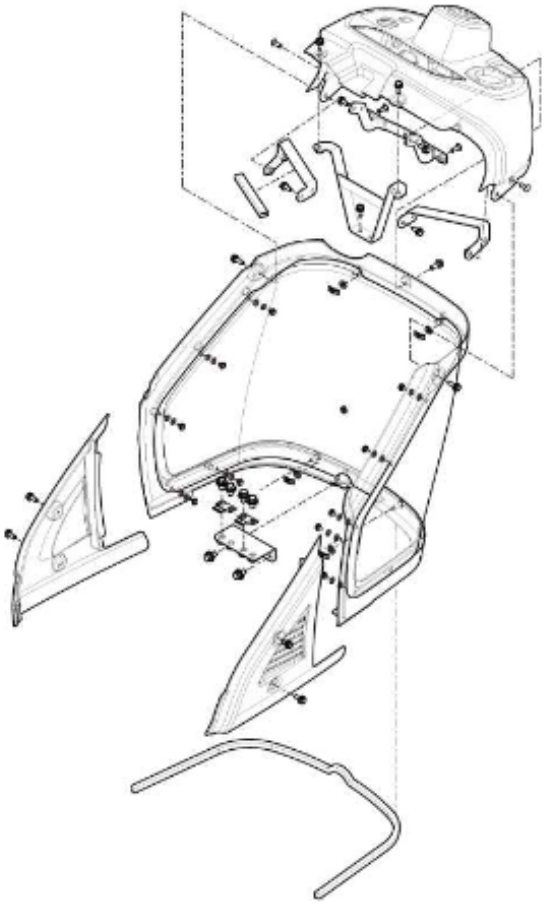


FIG.2-37 Covers

(2) Installation

Reassemble in reverse order of removal.

Note : Be careful not to overload M6 bolts and nuts extremely when they are tightened.

6. SEPARATION OF THE HYDRAULIC CYLINDER CASE AND TRANSMISSION

Parts which can be inspected during This operation
- Control valve
- Piston and lift crank linkage
- Relief valve and lowering speed valve
- PTO change gears.
- Differential device

Service of the HYDRAULIC CYLINDER CASE should be performed following the instructions in the paragraph : **5 SEPARATION OF THE EXTERIOR COMPONENT AND TRANSMISSION.**

(1) Removal

1) Remove the three point hitch.
Remove the Top link.
Remove the lift link(LH, RH).

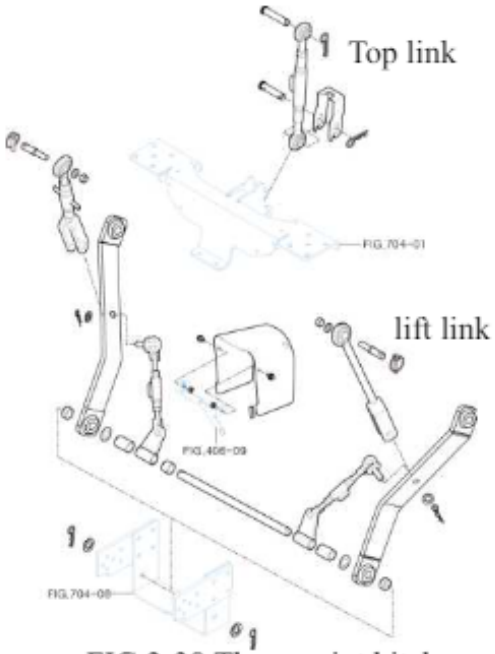


FIG.2-38 Three point hitch

2) Remove the drain pipe.

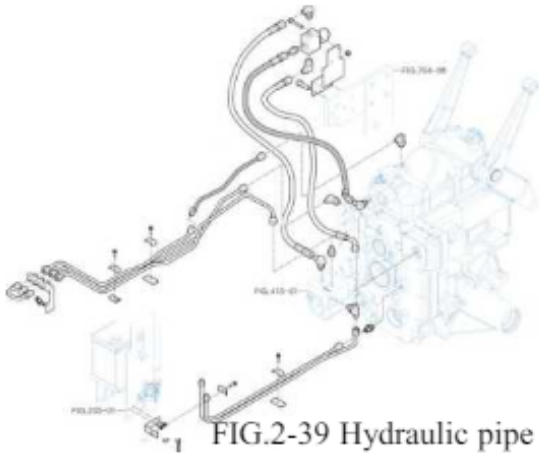


FIG.2-39 Hydraulic pipe

3) Detach the link B comp.

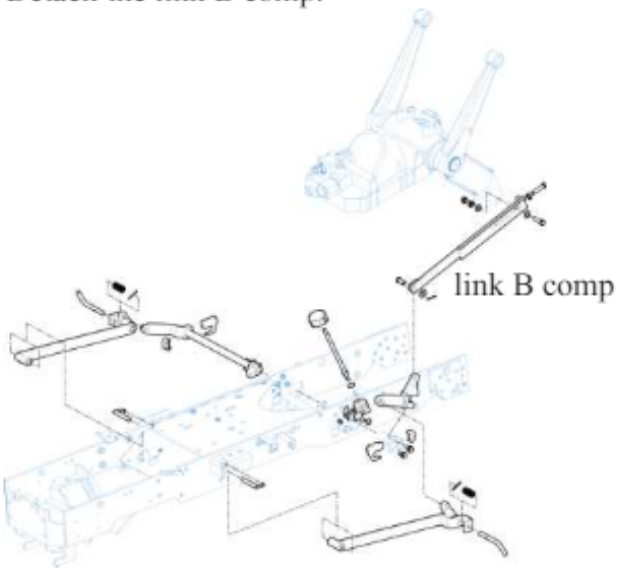


FIG.2-40 Mower Link

4) Detach the delivery pipe from the hydraulic cylinder case.

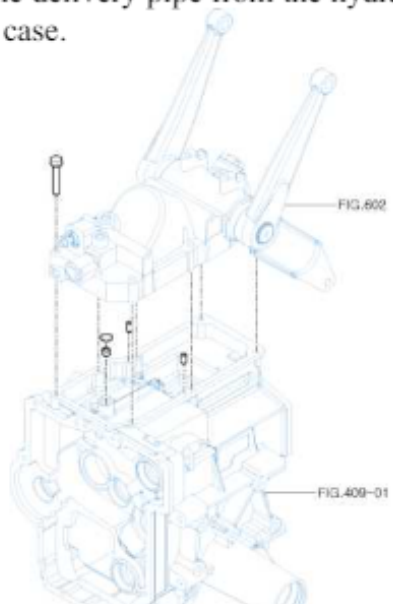


FIG.2-41 Hydraulic cylinder

Note : Be careful not to damage the functional components. When the pipes related to the hydraulic system are removed, their openings should be covered with plastic caps or the like to keep out dust or other foreign matter.

(2) Installation

Reassemble in reverse order of removal.

1) Install the pins (D08-16).
2) Apply the adhesive (TB 1215) on the rear transmission case.
3) Install the hydraulic cylinder case assembly. Tighten the bolts in order to number as shown in the FIG.2-42 to the specified torque.
4) After reassembly, make sure that the system functions properly.

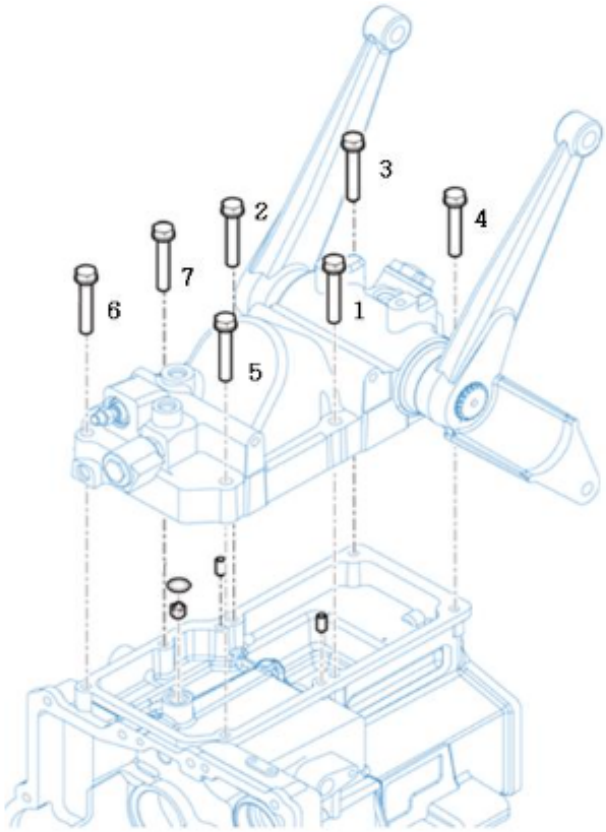


FIG.2-42 Hydraulic cylinder

Tightening torque	
M10x1.5P-55L	3.3 ~ 4.5 Kgf.m (23.8 ~ 32.5lb.fts)

7. SEPARATION OF THE TRANSMISSION AND REAR AXLE HOUSING

Parts which can be inspected during This operation
- MID PTO gears
- Final gears and brake system
- HST unit and input metal and PTO solenoid valve and PTO clutch assembly
- Range gears (Sub shifting) and MFWD gears
- Differential lock device
- Differential gears
- PTO gears

Service of the HYDRAULIC CYLINDER CASE should be performed following the instructions in the paragraph : **5 SEPARATION OF THE EXTERIOR COMPONENT AND TRANSMISSION.**

Note : Drain the oil into the transmission case ahead of time (3.7 gal / 14 Liter).

(1) Removal

● **HST unit**

1) Remove the HST unit after loosening the bolts (2xM8-75, 2xM8-140).

Note : Be careful not to fall down it into ground suddenly. There is oil remained in the case.

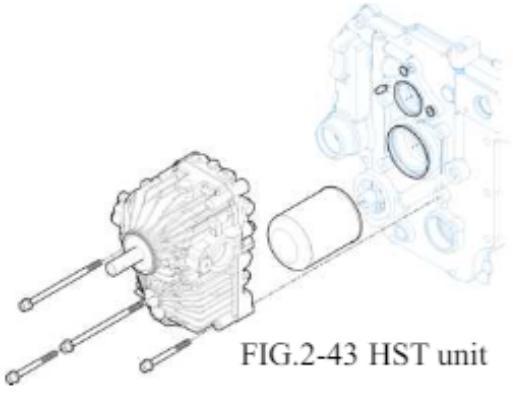


FIG.2-43 HST unit

Note : Be careful not to fall down sealants into ground suddenly..

Note :
Be careful not to damage the hydraulic functional components from dust or other foreign matter.

● **Rear axle housing assembly (LH, RH)**

Note : As both sides can be disassembled in the same way, only side (RH) will be explained here.

2) Lift up the transmission or support transmission with a crane or stands.
3) Remove the rear wheel.
4) Detach the brake rod (RH).
5) Remove the bolts which are tightened to the rear axle housing assembly.

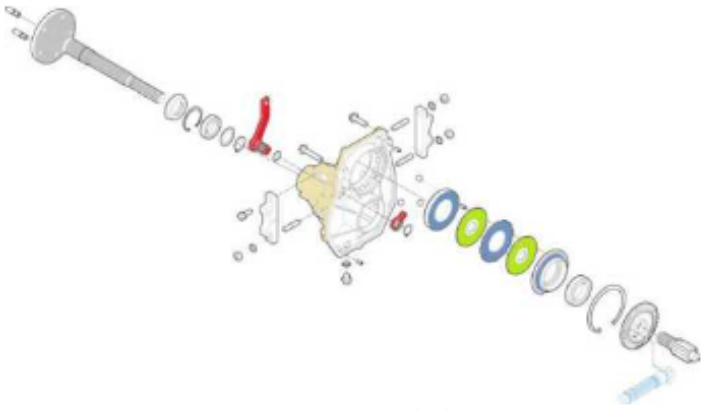


FIG.2-44 ear Axle housing(RH)

Tightening torque (Stud bolt)	
M10x1.5P-35L /50L	3.3 ~ 4.5 Kgf.m (23.8 ~ 32.5lb.fts)

Chapter 3

ENGINE ACCESSORIES

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8. Trouble shooting ----------3-6

SECTION 2. AIR CLEANER SYSTEM ----------3-7

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2. Elementary air-cleaner ----------3-8
3. Inspection of each part ----------3-9
4. Cleaning of the air cleaner ----------3-9
5. Element installation ----------3-10

SECTION 1. RADIATOR

1.General description

The pressure cooling system includes mainly the radiator, water pump, multi-blade fan, and

the thermostat. During the warm-up period, the thermostat remains closed and coolant is directed through by-pass to the suction side of the water pump.

Coolant then circulates through the cylinder block and water pump only to provide a uniform and fast warm-up period. Once the engine has reached operating temperature, the thermostat opens and coolant is pumped from the bottom of the radiator via the lower hose into the cylinder block. Here it circulates through the block and around the cylinders.

From the cylinder block, coolant is directed through the cylinder head and into the thermostat housing. With the thermostat open, coolant passes through the housing and upper radiator hose into the top of the radiator where it is circulated to dissipate heat.

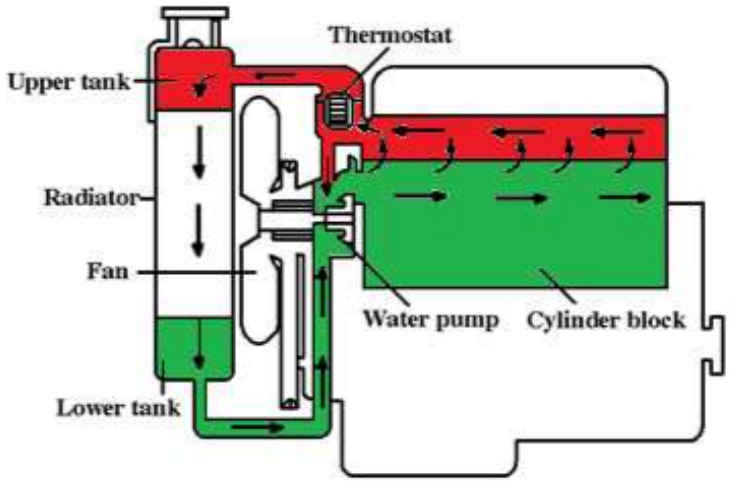


FIG.3-1

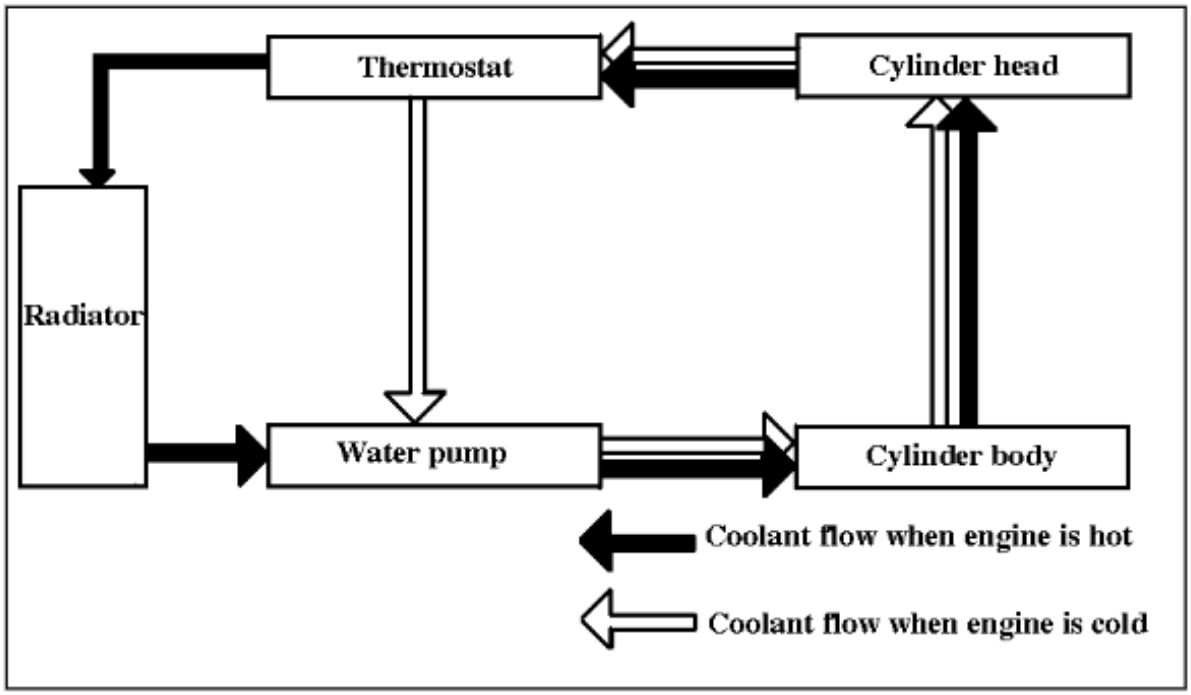


FIG.3-2

2. Radiator

The radiator consists of radiator cores, a tank to flow coolant, plates to install the radiator, and a fan guide. Fin-tube type cores are used and the cores and tank is made of anti corrosive aluminum and aluminum alloy.

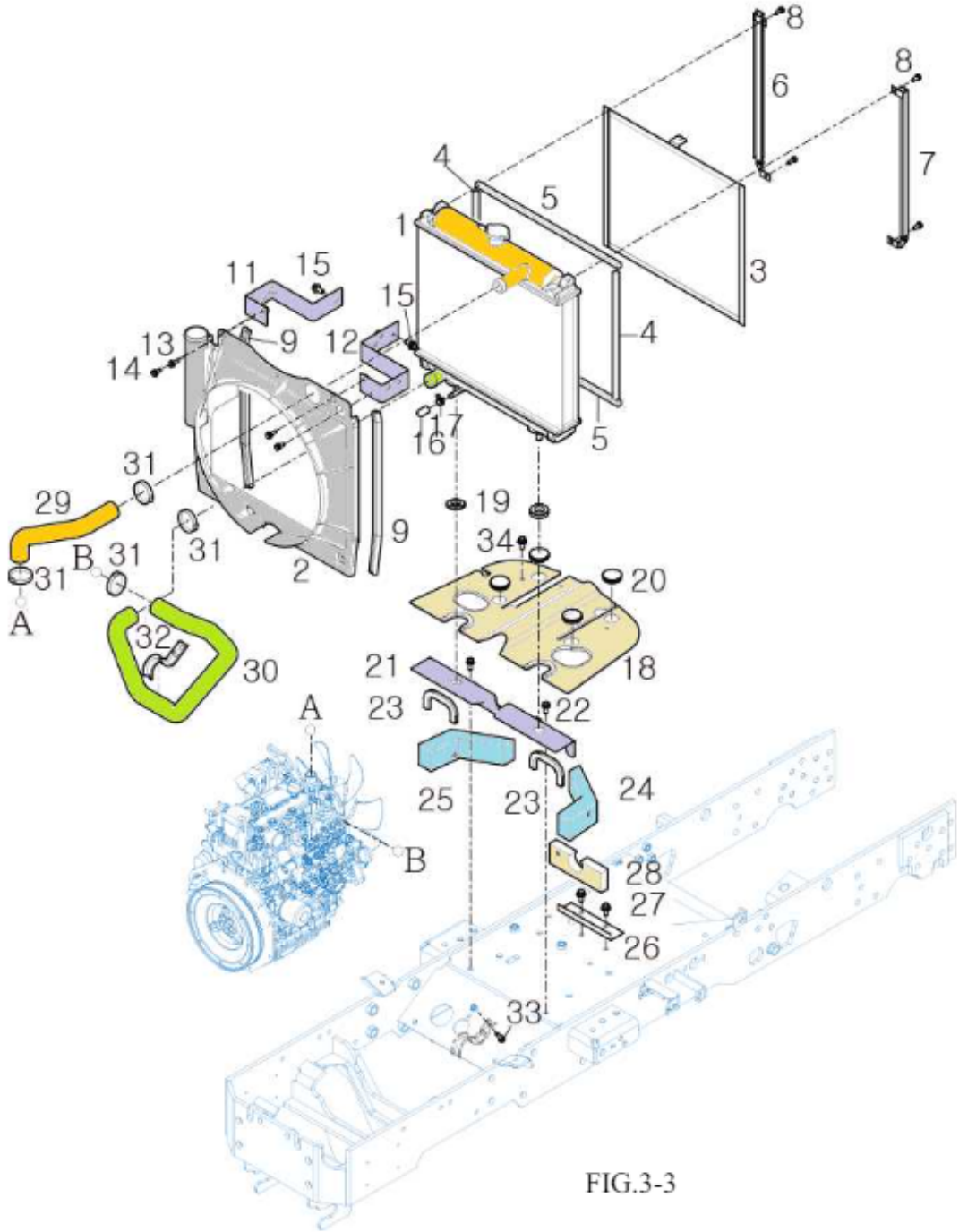


FIG.3-3

1.RADIATOR COMP 2.SHROUD 3.NET COMP, RADIATOR 4.SPONGE(315) 5.SPONGE , 410
6.NET FIX COMP RH 7.NET FIX COMP LH 8.BOLT , HEX /S 9.INSULATOR 400 11.RAD. BKT.RH
12.RAD. BKT. LH 13.BOLT , HEX /SP 14.BOLT , HEX /SP 15.BOLT , HEX/SP 16.CAP, RADIATOR
17.BAND CLAMP 16 18.DASH BOTTOM COVER 19.CUSHION RUBBER A , RADIATOR
20.CAP , RUBBER 30 21.RAD, BOTTOM BKT 22.BOLT , HEX/SP 23.PROTECTOR , 120
24.DASH BOTTOM SPG. LH 25.DASH BOTTOM SPG. RH 26.SEAL PLATE 27.BOLT , HEX/SP
28.DASH BOTTOM SPG , CENTER 29.RAD. HOSE , INLET 30.RAD. HOSE , OUTLET
31.BAND CLAMP 40 32.RAD HOSE HOLDER 33.BOLT , HEX /SP 34.BOLT , HEX /SP

3. SPECIFICATIONS

Description	eMax S20 HST
Radiator core type	CF (Wave fin)
Core train number	2 trains
Radiator fin pitch	3.5 mm
Thermal radiator area	6.2530㎡
Pressure valve opening pressure	0.9±0.15Kgf/ ㎠
Coolant capacity	5.2 ℓ **(C**ontains in cylinder block**), Radiator : 2.38** ℓ
Test pressure	1.5Kgf/㎠

4. REMOVAL OF THE RADIATOR

1) Drain the anti freeze through the drain plug.

2) Release the clamp and remove the upper hose.

3) Release the clamp and remove the lower hose.

4) Release the hose clamp and remove the water drain hose.

Note:

- Refer to the paragraph "SEPARATION OF THE ENGINE AND THE FRONT AXLE BRACKET in chapter 2 for operation up to this step.

-When removing the radiator, take care not to damage the radiator cores and oil cooler if equipped.

5. INSPECTION OF EACH PART

(1) Inspection for radiator water leaks.

Water leaks are liable to occur at the fitting portion between the upper tank and the core section or between the lower tank and the core section.
If any water leak should occur there, repair the leak by soldering.
Besides making a visual check, a more complete inspection should be accomplished as follows:

a. Leak test with compressed air.

Place the radiator as shown in the figure. Close the openings for water inlet and with something like a rubber plug and apply compressed air (1kgf/㎠ or 14.2psi) through the drain pipe into the radiator.

Excessively compressed air may damage the cores, so perform the air delivery carefully, watching the pressure gauge. Water leaks are inspected by watching for rising air bubbles.

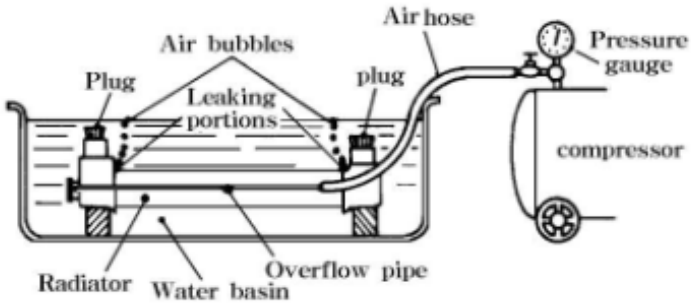


FIG.3-4

b. Leak test with a radiator cap tester

With the inlet and outlet pipes plugged up and the radiator filled with water, replace radiator cap with a radiator cap tester as shown in the figure.
Pump up the pressure in the radiator to the specified value and check to see if there are any leaks in the radiator.
When the radiator is water-tight, the pressure indicated on the pressure gauge does not increase, but if there are leaks, the pressure decreases.
This tester is also applicable for leak tests for the whole cooling system, not only for The radiator.
The test method is the same as mentioned above.

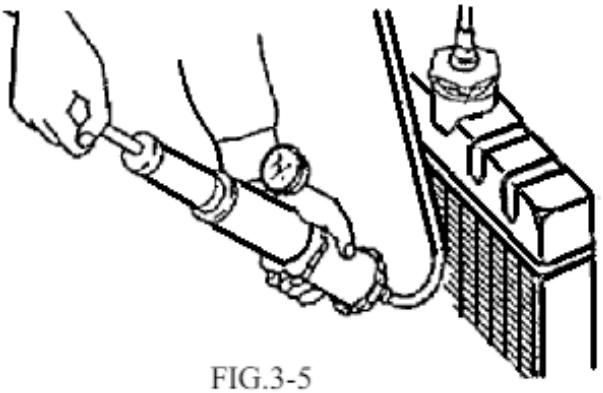


FIG.3-5

Testing Pressure	1.5Kgf/ /㎠

2) Inspection for radiator clogging

To inspect the radiator cores to see if they are clogged with fur or rust, remove the radiator cap and check for transparency of the coolant, and for rust or fur formation around the radiator throat inside the radiator.

If some rust or fur has formed or the coolant transparency is very poor, the radiator should be cleaned.

a. Cleaning the radiator inside.

-Place the radiator upside down and supply pressurized water from a faucet to the lower tank, draining through the upper tank, as shown in the figure to wash out accumulated deposits.

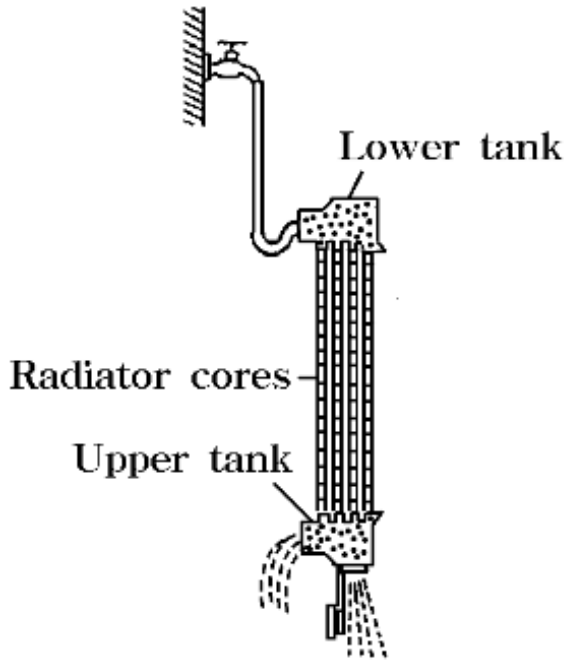


FIG.3-6

-Clean with a detergent
When cleaning the radiator with a detergent, follow the instructions given by its manufacturer. Different detergents have different characteristics.

b. Cleaning the radiator exterior

- Cleaning the net (wire mesh)
After the tractor has been operated in dusty conditions, check the net daily and clean it if necessary.

-Cleaning the radiator cores

Clean the radiator cores by applying water spray or compressed air so as to be a right angle with the radiator cores, moving water application in parallel.

Note:
When cleaning the radiator cores with pressurized water, be sure to apply it at a right angle to the cores. Slanted application might deform their cooling fins.

3) Visual inspection of the exterior parts

When the radiator exterior is corroded, cracked, or badly damaged, replace the radiator. Also replace damaged or fatigued water hoses.
Retighten loose hose clamps securely if water is leaking through the hose clamps securely, or replace them if necessary.

4) Inspection of the radiator cap.

Check the radiator cap to see if it functions normally, using a radiator cap tester as following.

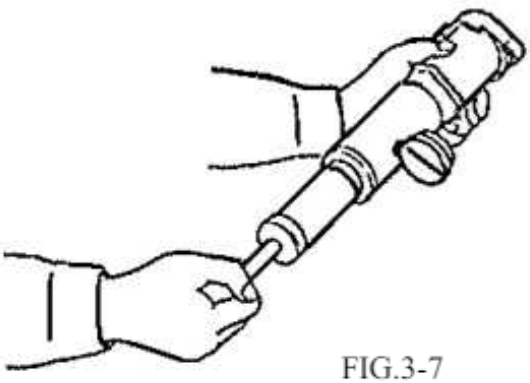


FIG.3-7

Pressure valve Opening pressure	0.9 Kgf/ ㎠ (12.79 psi)
Vacuum valve Opening pressure	0.04-0.05 Kgf/ ㎠ (0.57-0.71psi)

-Function test:

The pressure type radiator cap has a pressure valve and a vacuum as shown in the figure.

Both valves are held against their seats by springs while the pressure in the cooling system remains within a specified range, thus keeping the cooling system air-tight.

When the pressure in the radiator rises higher than the specified valves, it overcomes the force of the pressure valve spring and open the pressure valve to release excess pressure through the overflow pipe as shown in the figure.

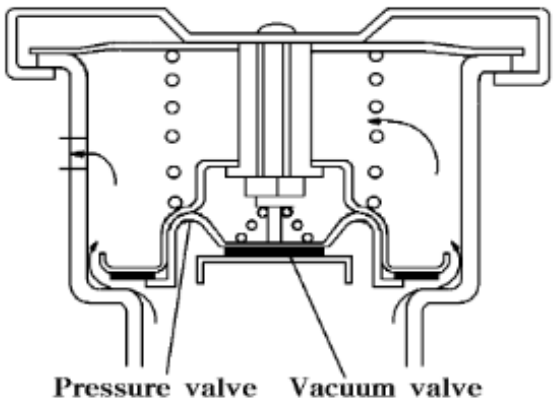


FIG.3-8

When the coolant temperature falls enough to cause the vapor to condense in the cooling system and decrease the coolant volume, the radiator pressure becomes negative. When this occurs, the vacuum valve opens to let outside air into the radiator as shown in the figure, thus preventing the radiator from being deformed.

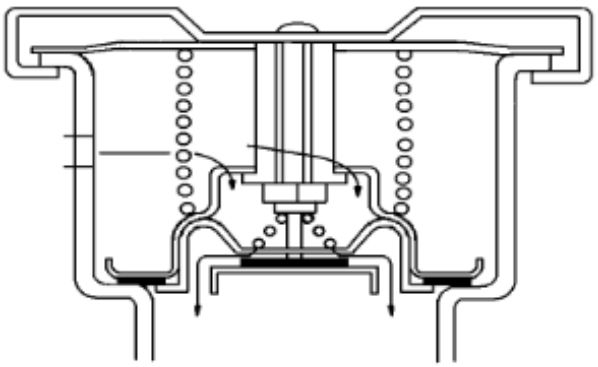


FIG.3-9

6. RADIATOR REASSEMBLY

Reassemble the radiator in the reverse order of disassembly.

Note:

- The rubber hoses should be clamped securely and must not interfere with the cooling fan.
- The radiator cores must not interfere with the cooling fan.

7. DAILY INSPECTION

1) Coolant level inspection and coolant replacement

When the radiator is hot after operation, be sure to wait until the coolant cools down sufficiently before removing the radiator cap.
If this is not done, heated vapor might burst out and cause burns. Use fresh water from a faucet as the coolant. When the coolant is replenished or changed, let the engine idle for a while for the coolant to circulate sufficiently in the cooling system and replenish if necessary after stopping the engine.

2)Antifreeze

When the weather is cold, use an antifreeze to prevent the engine from freezing. The freezing point differs according to the mixture ration of water and antifreeze. Therefore, prepare an antifreeze solution which will have a freezing point 5℃ lower than the estimated lowest atmospheric temperature in your environment.

Precaution for filling antifreeze.

- The radiator interior should be washed clean ahead of time.
- As concerns of mixing ratio of an antifreeze, follow its manufactures' instructions.
- Antifreeze should be blended well with water before filling.
- When the coolant level is lowered due to evaporation, maintain the level by adding water, not by using an antifreeze solution.
- When the coolant level is lowered due to leaks, maintain the level by adding an antifreeze solution of the same mixing ratio.
- As antifreeze corrodes point, take care not to spill it on painted parts.

-The tractor is filled with a permanent type antifreeze (Mobile Long Life Coolant) when shipping (Mixing ratio : 50%).

TABLE 3-1

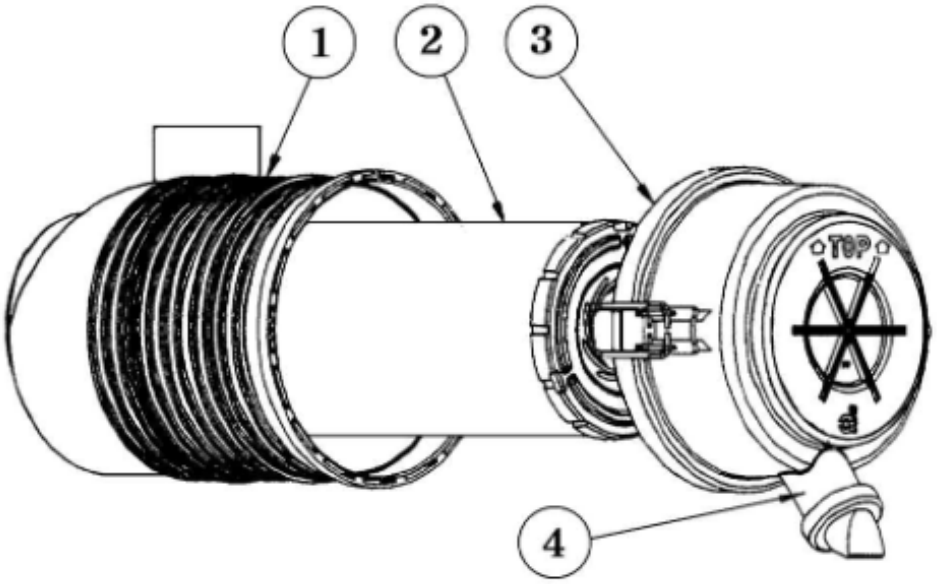
Problems	Causes	Countermeasures
1) Overheating	(1) Low coolant level	(1)Replenish coolant and inspect water leaks.
	(2) Fatigued pressure valve spring	(2)Replace radiator cap.
	(3) Loose or broken fan belt	(3)Adjust belt tension or replace.
	(4) Oily fan belt	(4)Replace.
	(5) Poor thermostat	(5)Replace.
	(6) Poor water pump or water leaks	(6)Repair or replace.
	(7) Clogged water passages	(7)Clean radiator and water passages.
	(8) Improper injection timing	(8) Adjust injection timing.
	(9) Clogged air ways	(9) Clean radiator exterior.
	(10) Fuel gas enters water jacket due to broken cylinder gasket	(10) Inspect cylinder head and replace cylinder gasket
2) Overcooling	(1) Poor thermostat	(1)Replace
	(2) Excessive low atmospheric temperature	(2) Decrease radiator working area by radiator masking.
3)Lose of coolant	(1) Leaking radiator	(1)Repair or replace
	(2) Loosely clamped or broken water hose	(2)Retighten or replace
	(3) Fatigued pressure valve spring	(3)Replace radiator cap
	(4) Leaking water pump	(4)Repair or replace
	(5) Water leakage through cylinder head gasket	(5) Inspect cylinder head and Replace gasket
	(6) Cracked cylinder head or body	(6)Replace
4) Noisy cooling fan	(1) Poor water pump bearing	(1)Replace
	(2) Loose or bent fan	(2)Retighten or replace
	(3) Unbalanced fan	(3)Replace.
	(4) Poor fan belt	(4)Replace.

SECTION 2. AIR CLEANING SYSTEM

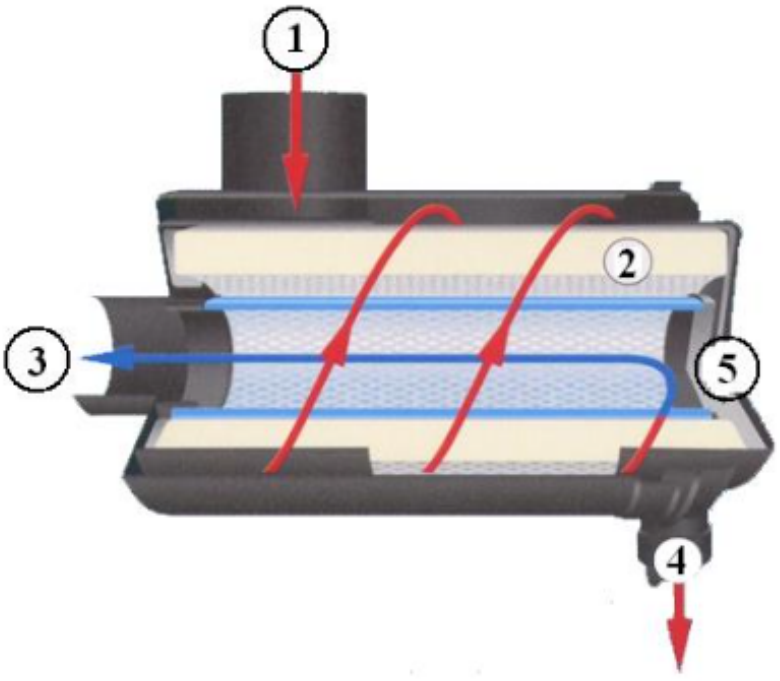
1.GENERAL DESCRIPTION

Unfiltered air contains many particles harmful to the engine such as dust, sand, or other foreign matter. When such foreign matter have entered in to the engine, they have mixed into the lubricant and promote wear of lubrication parts in addition to damaging the piston cylinders. To eliminate these harmful particles, an air cleaner has been installed. The air cleaner which is installed on the tractor is a dry, cyclone type and is constructed as shown in the figure.

Under the influence of suction generated by the engine, unfiltered air flows through air inlet tube and is forced into a high-speed centrifugal motion. By this circulating action most of the dust and dirt Particles are separated from the air and collected in the dust unloading valve(4).
The remaining dust is removed as the air flows through the paper element(2) before being drawn into the engine.



① Body
② Paper element outer
③ Cover assembly
④ Dust unloading valve



1. **A**ir inlet
2. Paper element
3. Air outlet
4. Dust unloading valve
5. Packing

FIG.3-10 Air Cleaner

2.ELEMENT AIR CLEANER

1) SPECIFICATIONS.

Model		eMax S20 HST
Type		Dry, paper element filtering type
Rated intake air volume (M^3/min)		1.5
Effective filter area (M^2)		0.44
air venting resistance (㎜Ag)		110 or less
Total filtering efficiency (%)		99 or over
Filter material	Outer Element	Paper / 11201032020

2) DISASSEMBLY

Remove the Clamping which clamps the cover and take out the element.

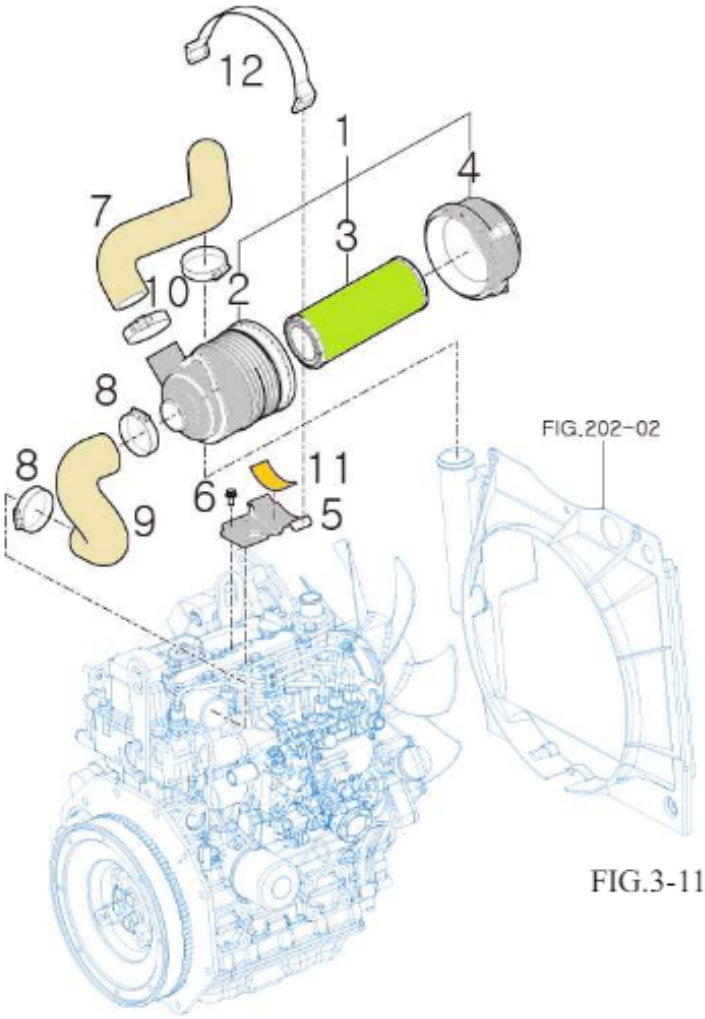


FIG.3-11

1.AIR CLEANER ASSY
2.BODY
3.ELEMENT
4.COVER
5.AIR CLEANER BKT
6.BOLT , HEX /SP
7.HOSE , AIRCLENER INLET
8.BAND CLAMP 64
9.HOSE , AIRCLENER OUTLET
10.BAND CLAMP 64
11.RUBBER PLATE
12.RUBBER COMP

3. INSPECTION OF EACH PART

1) Inspection of the cleaner body

(1) Check the cleaner exterior for cracks, deformation or damage and repair or replace if necessary.

(2) Check each packing for fatigue or damage and replace if necessary.

Fig. 3-12

2) Inspection of rubber hoses

Check the rubber hoses for fatigue or damage and replace if necessary.

3) Inspection of the paper element

To check the element for damage, Dry it sufficiently after washing and put an electric bulb in to the element and look for damage.

Fig. 3-13 Element check

Note:

Especially note the glue portions of the paper and metal parts.

4. CLEANING THE AIR CLEANER

Clean the air cleaner after 100 hours of operation or less depending on conditions in the following manner.

1) When the air cleaner is cleaned or the element is replaced, dust accumulated inside the air cleaner body should be removed with a cloth. As inhaled dust causes engine wear, remove a dust accumulated inside the inlet pipe, the rubber hose which connects in the inlet pipe and the air cleaner, the inlet manifold and inlet port.

(1) When accumulated dust is dry.

-When removing the dust in the element, hold the element by a hand and pat the side wall with other hand. Never hit the element against a stone or a concrete wall because that might cause its side wall to peel off.

-apply compressed air from inside of the element to blow dust off while turning the element by hand.

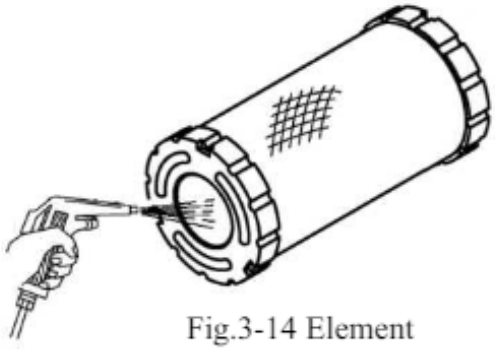


Fig.3-14 Element

Note:

The compressed air to be applied should not have a pressure of more than 7㎏/㎠(99.6psi) Maintain sufficient distance between the air gun and the element.

5.ELEMENT INSTALLATION

Install the element in the reverse order of disassembly, but follow these instructions.

1) Each tightening clamp must be secured and care must be taken not to miss the latch.

2) Before installing the element, clean the rubber packing on the top of the element.

Note : The element should be tightened exactly so that it will not become loosening during operation

Chapter 4

HST SYSTEM

SECTION 1. INTRODUCTION ---------- 4-1

SECTION 2. GENERAL SPECIFICATIONS ---------- 4-2

SECTION 3. COMPONENT LOCATION ---------- 4-3

SECTION 4. TROUBLESHOOTING ---------- 4-6

SECTION 5. DIAGNOSTICS ---------- 4-8

SECTION 6. THEORY OF OPERATION ---------- 4-9

SECTION 7. TESTS AND ADJUSTMENT ---------- 4-15

SECTION 8. REPAIR ---------- 4-19

SECTION 1. INTRODUCTION

1. Introduction

This Manual describes the specifications, structure, mechanism, and handling about a two-shaft HST used as a continuously variable transmission for road vehicles in order to prevent any nonconformity of handling and keep its good performance for the long run.

<WORD MESSAGE>

Each Word Message of 'DANGER', 'WARNING', 'CAUTION' in this Manual is defined as follows. It is needless to say that the marking of Word Messages is so important for a safe work and handling of machine/equipment in the field that everyone should understand the messages fully and comply to them.

⚠ **DANGER**	**It marks an imminent danger resulting to death or serious injury if handling wrongly.**
⚠ **WARNING**	**It marks an imminent danger resulting to death or serious injury if handling wrongly.**
⚠ **CAUTION**	**It marks any possibility resulting to a slight or moderate injury or to physical damage if handling wrongly .**

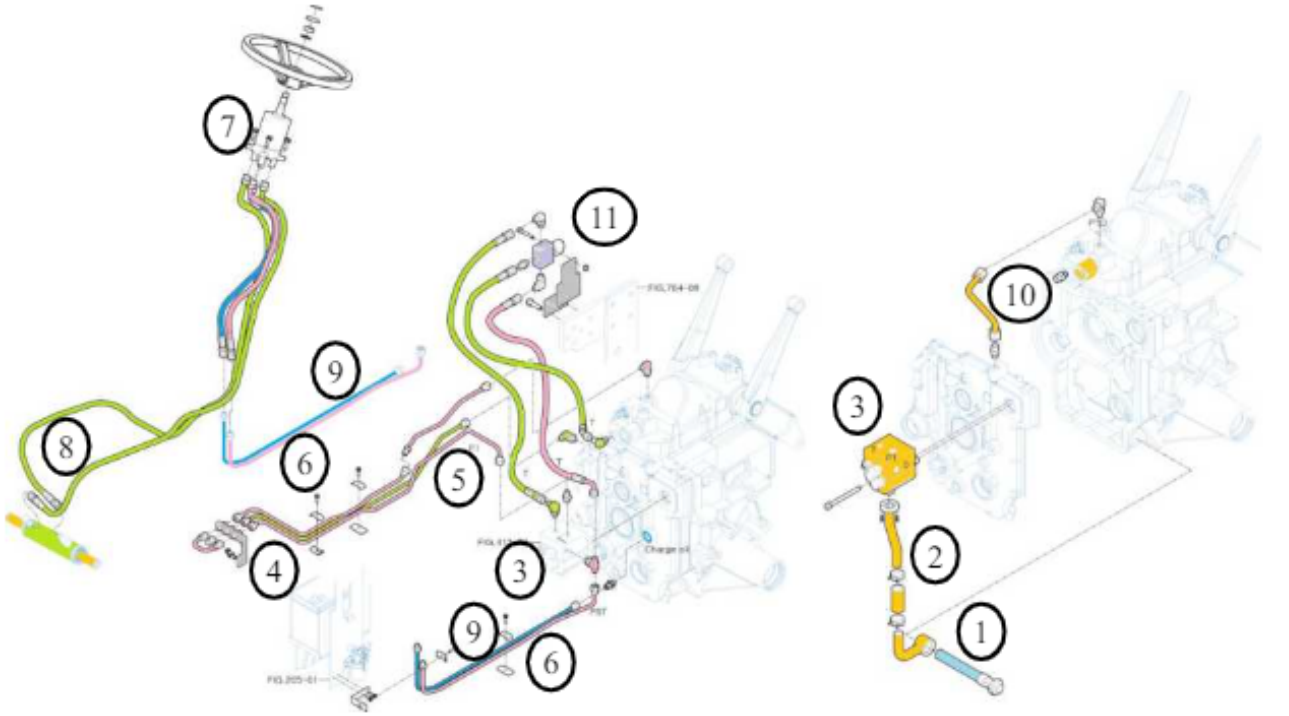
SECTION 2. GENERAL SPECIFICATIONS

< HST for Unroad Vehicles >

Item		SPECs	
HST Capacity		PUMP	0~23cc/rev
		MOTOR	23cc/rev
Basic SPECs	DIRECTION OF INPUT ROTATION	From the position of clockwise input shaft	
	CHARGE RELIEF SET PRESSURE	9-10 bar , VG46, 50˚C, 8 L/min	
	DRAIN PRESSURE	Within 0.3 bar	
	FILTER	10Иm	
	STRAINER	150Иm	
	OIL POLLUTION DEGREE	Within NAS 9 Level	
Conditions of Use for Customers	ENGINE HP	19PS/3000rpm	
	INPUT ROTATION	970~3250 /No-Load Max. 3300	
	TEMPERATUE RANGE OF HYDRAULIC OIL	Common Temp.:+10~+80˚C Limit:-20~+82˚C	
	MAX. VIBRATION	Within 9G	
	DRIVING METHOD	Input shaft: Direct coupling	
		Output shaft: Direct coupling	

SECTION 3. COMPONENT LOCATION

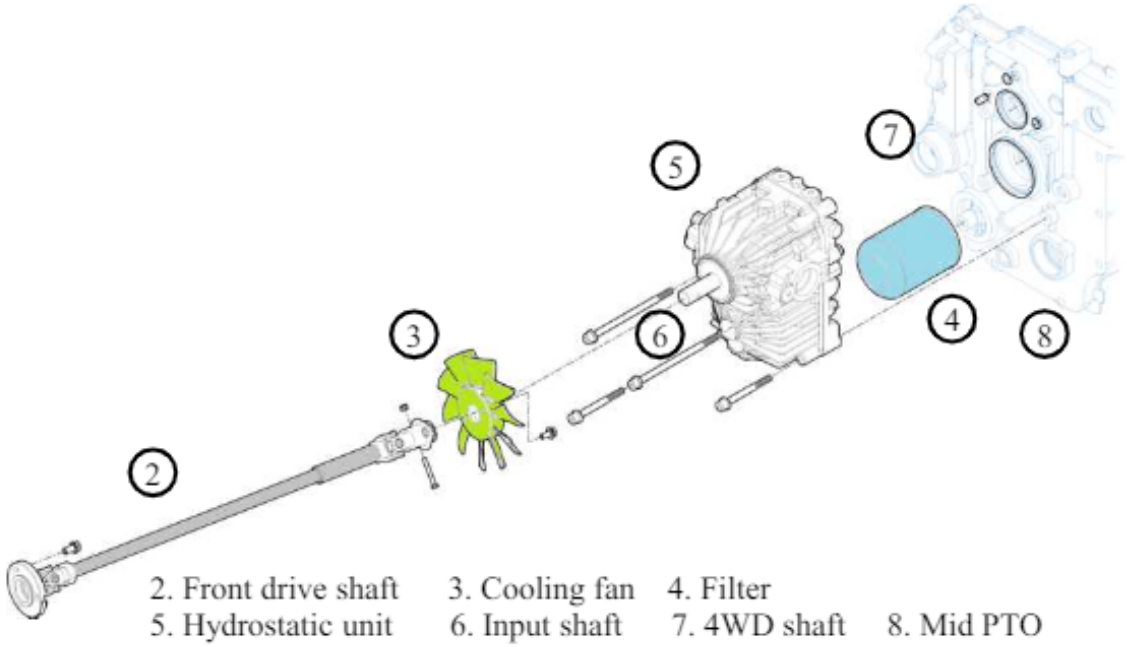
1. Hydraulic Hoses and lines.



1. Hydraulic oil filter 2. Suction pipe 3. Gear pump 4. Delivery pipe 5. Drain pipe
6. Steering pipe 7. Steering valve 8. Power steering pipe(LH/RH) 9. Charge pipe
10. PTO pipe 11. Extra valve

Fig.4-1

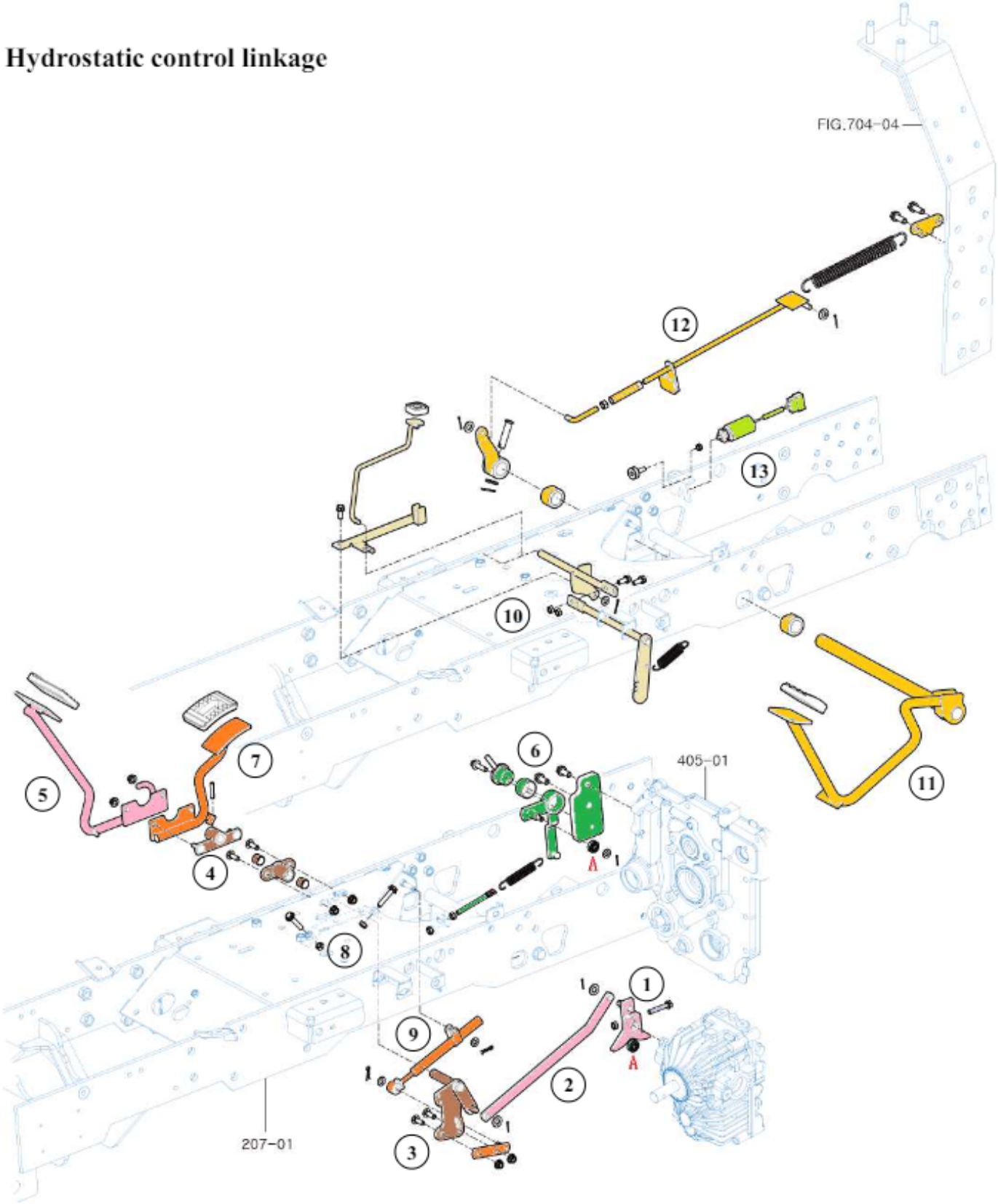
2. Hydrostatic Transmission



2. Front drive shaft 3. Cooling fan 4. Filter
5. Hydrostatic unit 6. Input shaft 7. 4WD shaft 8. Mid PTO

Fig.4-2

3. Hydrostatic control linkage



1. Holder comp
2. Control rod assembly
3. Pedal shaft comp.
4. Arm comp.
5. Forward pedal comp
6. Neutral arm comp
7. Reverse pedal comp
8. Stopper comp
9. Damper , oil
10. Parking brake comp
11. Brake Pedal comp
12. Brake Rod
13. Brake sensor

Fig. 4-3

4. Hydrostatic system schematic

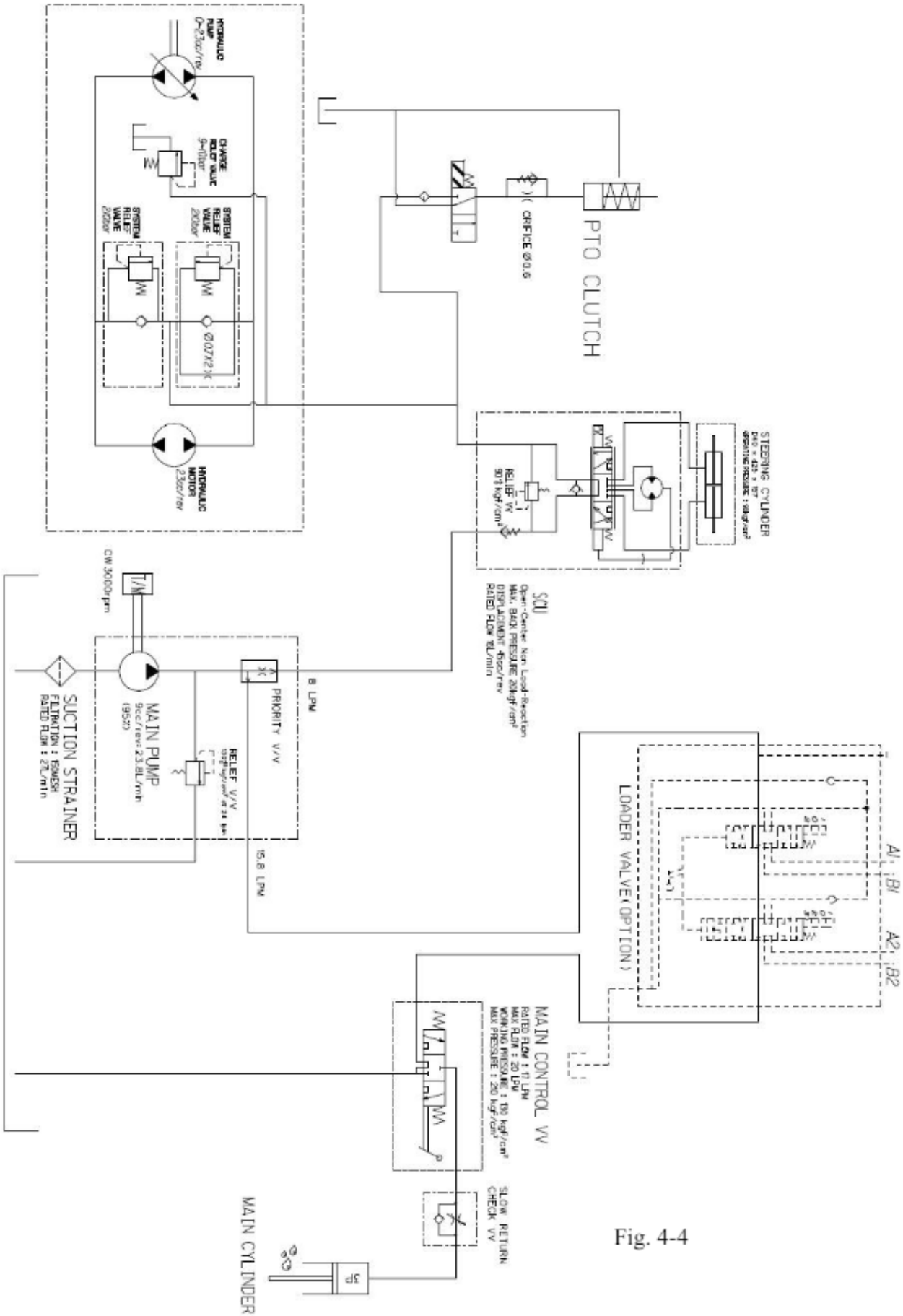


Fig. 4-4

SECTION 4. TROUBLESHOOTING

1. Troubleshooting

In case that HST shows troubles, it is as a general rule to replace the Assy. For a more clear-cut explanation and understanding, here is a detailed outline of troubles, causes, checking points, and actions.

TROUBLE	CAUSE	CHECK LIST	ACTION
1. Even when turning an operating lever, Output Shaft does not rotate.	1. A set value of Low Pressure Relief Valve drops.	Measure the pressure of Charge Circuit and check that it reaches its set value.	Replace with a new component if failing to go up to a specified pressure.
	2. A set value of High Pressure Relief Valve drops.	Measure the pressure of High Pressure Circuit and check that it reaches its specified value.	Replace with a new component if failing to go up to its specified pressure.
	3. The Seat of Check Valve (HST) is defective. (Low/high pressure state of HST is out of normality)	Measure the pressure of Charge Circuit and Low Pressure Circuit, and check that it reaches its specified value.	Replace with a new component if failing to go up to its specified pressure.
	4. Gear Pump gets damaged. Flow rate drops.	Measure the pressure of Charge Circuit and check that it reaches its specified pressure.	Replace with a new component if failing to go up to its specified pressure.
	5. Air comes into HST.	- Let the air out of HST. - Check the flow rate of tank. -Check if pipe is out of order (ex: suction of air caused by defective seal).	- Replenish a hydraulic oil (operating oil). - Repair the pipe.
	6. Main parts of HST malfunction because of being damaged. Input/output shaft or coupling shows problem.	- Check that output rotation number of HST goes up to its specified value. - Check if Spline of Coupling is worn out.	- Replace with a new Coupling. - Clean the Hydraulic Circuit in Main Body and replace with a new HST ASSY.
2. Even when placing a Pedal in its neutral position, rotation does not stop.	1.Check Valve malfunctions. (ex: Hole is clogged)	- Measure the pressure of High Pressure Circuit. - Check the conversion state of high and low pressure when moving it backward/forward.	After going through disassembly and washing process, reassemble it.
	2. A Moving Swash Plate is worn out.	Adjust the Pedal slightly from its neutral position and check that there is any point where its output rotation stops.	Replace with a new component if there is no point where its output rotation stops.
	3. An operating torque of Lever increases. The force of Return Spring, at the end of Main Body Link, deteriorates, which makes the return force of Pedal poor.	- Measure an operating torque at the end of Trunnion Shaft. - Check the force of Return Spring.	Replace with a new Swash Plate Bush. Replace with a new Link Part.

TROUBLE	CAUSE	CHECK LIST	ACTION
3. HST output and rotation are insufficient.	1. The flow rate of Charge is short because of having Filter or Strainer (Main Body) clogged.	Measure the pressure of Charge Circuit and check that it reaches its specified pressure.	Wash the Filter/Strainer, or replace with a new one.
	2. Air is flowed into HST.	Discharge HST Air, and check the state of tank flow rate. Check if pipe is out of order (ex: Air suction caused by seal defect)	Repair the pipe of supplying a hydraulic oil (operating oil).
	3. The flow rate of Charge is short.	Measure the pressure of Charge Circuit and check that it reaches its specified pressure. If it fails to reach its specified pressure, check if Gear Pump is out of order.	Replace with a new Gear Pump Assy.
	4. A high rate of hydraulic oil runs because of having the vibration part of HST pump or motor worn.	Check that HST Output Rotation goes up to its specified value.	Clean the Hydraulic Circuit in Main Body, and replace with a new HST Assy.
4. HST makes a noise	1. Air comes into HST.	- Check the flow rate of tank. - Check if pipe is out of order (ex: Air suction caused by seal defect)	-Let the air out of HST, and supply a hydraulic oil (operating oil). - Repair the pipe.
	2. The flow rate of Charge is insufficient because of having Filter/Strainer of Main Body clogged.	Measure the pressure of Charge Circuit and check that it reaches its specified pressure.	Wash the Filter/Strainer, and replace with a new one.
	3. Link part of Main Body is loose or worn.	Check that noise decreases when covering the Link part with hands.	Adjust and repair the Link part.
	4. The clearance of Input/Output Shaft and Coupling gets wider.	Check if Input/Output Shaft and Coupling gets loose or worn.	Replace with a new Coupling.
	5. The internal components of HST are defective, worn, or damaged.	Check that output rotation of HST reaches its specified value when jacking up vehicle and idling engine. .	Replace with a new HST Assy.
5. Oil flows out of Shaft and Seal Part.	1. Abnormal rise of oil temperature damages Oil Seal, O-ring, and Gasket, etc.	Check if oil temperature rises over its specified value.	-Repair the pipe if finding no problem in Hydraulic Circuit (Oil Cooler). - Replace with a new Seal Component.
	2. Oil outflows because of damage in Oil Seal, O-ring and Gasket (caused by an excessive internal pressure inside the case of HST)	Check if the pressure of pipe rises over its specified value.	Repair the pipe and replace with a new Seal Component if fining any problem in pipe.
6. The return of Pedal is slow, or it is difficult to do it.	1. Operating torque of HST Lever increases (Hysteresis UP)	Measure the torque at the end of Trunnion Shaft.	Replace with a new Swash Plate and Bush.
	2. The force of Link Return Spring deteriorates. Free cushion of spring part increases.	Check the state of Return Spring.	Change the Link Part. Adjust the force of Spring.

Test conditions:

- Operator in seat
- Key switch in RUN position

Test/Check point	Normal	If Not normal
1. Control pedals	Pedal should move freely	Check linkage from pedals to pump

Test conditions:

- Start engine and run at slow idle

Test/Check point	Normal	If Not normal
2. Directional pedals are in neutral position	Machine should not creep forward or backward	Adjust centering of pump control pedals (Neutral Adjustment Knob)
3. Move forwards or reverse pedal slowly from neutral to maximum travel speed position	Machine should accelerate smoothly forward or backwards.	Check the tension spring Check the location of damper Check fluid reservoir for proper fluid level. Check hydraulic pipe and connections for leaks. Perform system flow and pressure checks to verify proper operation of charge pump and hydrostatic pump
4. Control pedal in full forward position	Machine should move forward	Check pedals and forward/reverse linkage for damage. Check forward drive pressure relief valve
5. Control pedal in full reverse position	Machine should move backward	Check pedals and forward/reverse linkage for damage. Check reverse drive pressure relief valve.

HYDROSTATIC SYSTEM

The hydrostatic system provides a means to transfer. Power from the engine to the final drive to the wheels. It also provides infinitely variable speed control, forward or reverse, by foot pedal operation.

1. Operation

※ Each operation drawing is a schematic diagram, so there may be slightly differences in real product, size and shape.

1) PUMP, MOTOR CIRCUIT (Variable Pump)

<Figure-a> show a rotation part of AXIAL PISTON PUMP(SWASH PLATE TYPE) With 9 pistons inserted to cylinder block. When shaft rotates, so does cylinder block together.(Swash plate does not rotate). If Shaft Center and Swash Plate are connected with each other vertically, as shown in <Figure-a>, Space A and B (Cylindrical space of Cylinder Block) have the same volume so that they do not work suction and discharge, therefore there is no pump action.

If rotating the Swash Plate ask as much as 'a', as shown in <Figure-b> each volume of Space A and B is changed as shown in the drawing(A>B). In this condition, if rotating the shaft in the direction of θ, oil is sucked betweens 180° where piston moves from B to A.

So, if connecting suction and discharge pipe to two crescent ports, it becomes one PUMP.

In this case, Ps becomes a suction port and Pd becomes a discharge port. On the contrary, if rotating the Swash towards, Ps becomes a discharge port and Pd becomes a suction port.

The next is about discharge capacity. As described above, in case of 'α=0', there is no suction and discharge. The bigger the volumetric difference between Space A and B is (That is to say, as much as its slant angel).the bigger its flow rate is..

In this case, discharge capacity of pump is calculated as follows:

$$Q = \underline{D\ PMAX \cdot \tan a \cdot N\ in \cdot \eta\ vp} / \tan(a\ Max) = \quad (㎤/min)$$

D PMAX : Max. Capacity of PUMP (㎤/rev)

a : Swivel Angle of Swash Plate (deg)

a MaX : Max. Inclination Angle of Swash Plate (Swivel angle) (deg)

N in : Pump Input Rotation (rpm)

η vp : Pump Volume Efficiency (%)

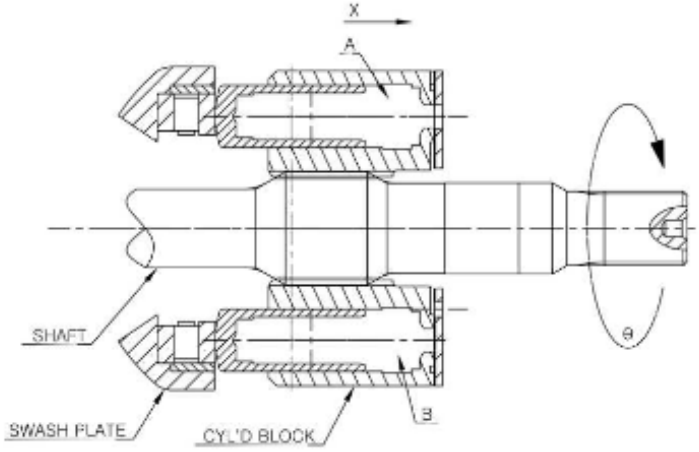


Figure-a

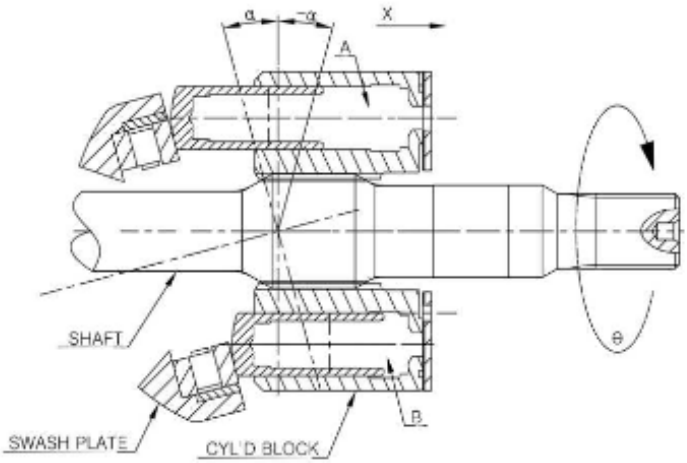


Figure-b

(MOTOR)

<Figure-c> shows a rotation parts in Axial Piston Pump, and 9 pistons are inserted to Cylinder Block. At the end of Cylinder Block, there is Valve Plate with two crescent passages (Ps and Pd), and the two crescent passages are connected to inlet pipe and discharge pipe respectively.

In this condition, if having high pressure oil delivered from Ps Port, piston will be pressed and Swash Plate will be affected by Force (F). The force component (Ft) of this Force's rotation direction rotates Cylinder Block, which makes its Spline get in and generated torque in the Shaft towards ω and finally works Motor.

Output torque of Motor is calculated as follows:

$$T = (\underline{P \cdot Dm \cdot \eta m}) / 2\pi \ (N.m)$$

Dm : Motor Capacity (㎤/rev)

P : Working Pressure (MPa)

ηm : Torque Efficiency (%)

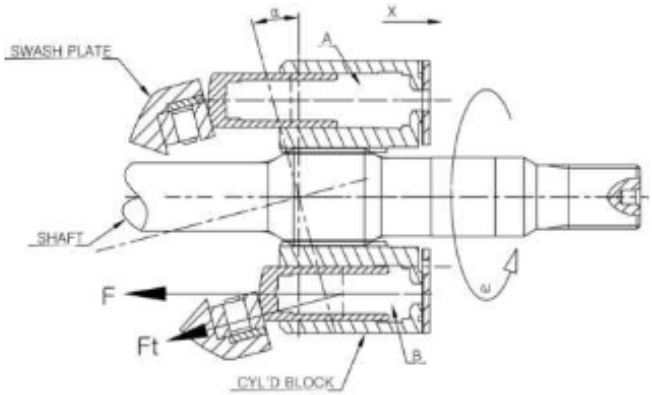
The number of rotation is changed by flow pressure, and it is calculated as follows:

$$N = (\underline{Q.\eta vm}) / Dm$$

Q : Inflow Quantity (㎤/min)

η vm : Motor Volume Efficiency

At this time, hydraulic oil (operating oil) is discharged from Pd Port. Reversely, if drawing pressure oil from Pd Port, it rotates contrary to the above expression.



<Figure-c>

2) CHARGE CIRCUIT

HST Circuit has an internal gap, so it is equipped with CHARGE CIRCUIT to compensate the weak point. Oil discharged from CHARGE PUMP is to be supplied to Pump and Motor through

CHECK VALVE, discharged from CHARGE PUMP, flows into the case through low

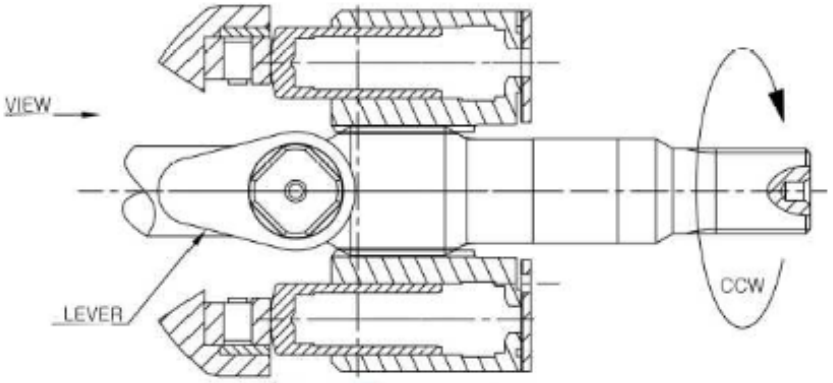
-pressure Relief Valve and comes back to tank..

3) H S T Operation

(a) NEUTRAL (LEVER : Neutral Position)----------Figure-d

A variable pump does not work even if rotating the input shaft of HST. Oil it not supplied from pump to motor and output shaft does not rotate. Two high-pressure passages linking pump and motor are connected to charge circuit.

The remaining oil that is supplied to main circuit via Check Valve, discharged from GEAR PUMP (CHARGE PUMP), flows into the case through low-pressure Relief Valve and comes back to tank.

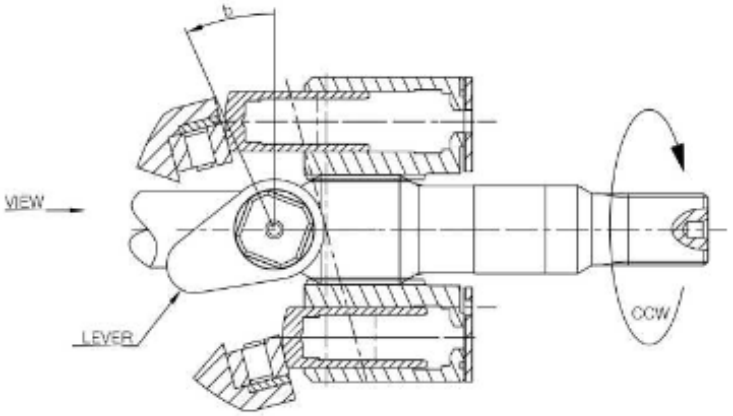


<Figure-d>

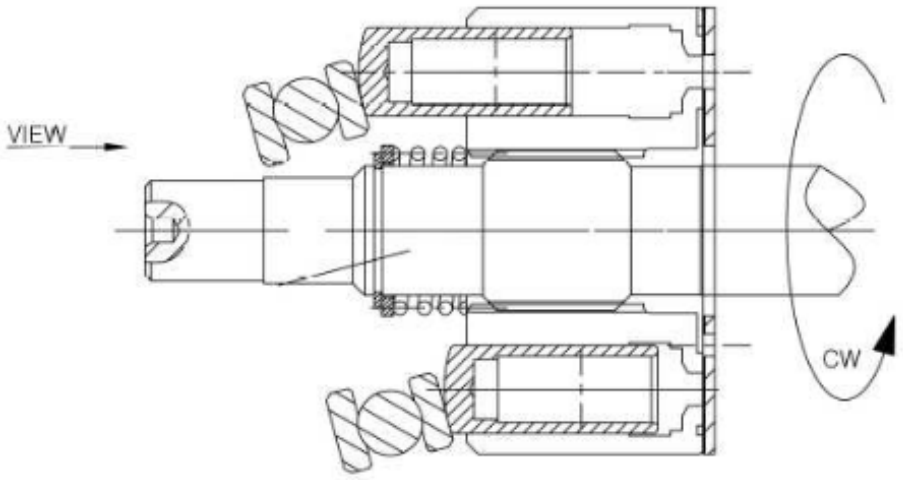
(b) FORWARD (LEVER: b side)---------- Figure-e

In case of rotating the input shaft of HST to the CCW direction and tilting LEVER from its neutral position to the direction of 'b': When the LEVER is at a minimum inclination angle, pump does not work not to make a volumetric difference of inner cylinder. If tiling the LEVER above the taper angle of moving Swash Plate,

Pump starts to run and supply motor with oil, and output rotation is directed to CW when seeing it from the VIEW that position of output shaft.<Figure-f>.



<Figure-e>



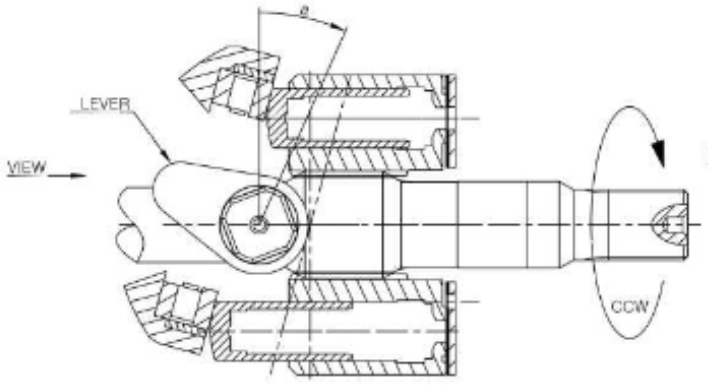
<Figure-f>

And Relief Valve is usually closed. If the output shaft of motor is overloaded and pressure inside the HST circuit is over 210bar, Relief Valve works to prevent the damage of each equipment.

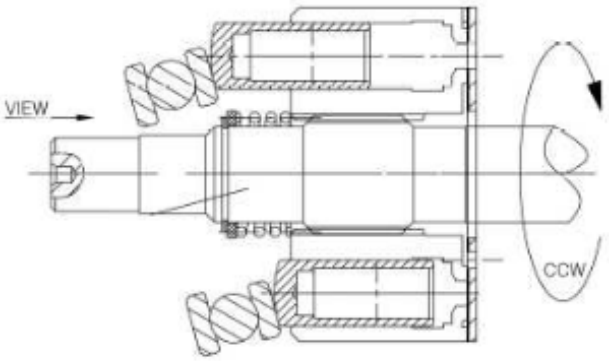
In this case, energy is all transformed to heat and oil temperature inside the HST Circuit rises sharply. So operation of Relief Valve has to last just for as a short time as possible(Within 30 seconds). Oil that has already passed through Relief Valve is flowed into low-pressure circuit.

(c) BACKWARD (LEVER : a side)----------Figure-g

The operation principle is the same as the above FORWARD operation.
In case of tilting the LEVER to the direction of 'a' and tilting the LEVER above the tapper angle of moving Swash Plate, pump starts to discharge oil and supply motor with oil, and output shaft rotates. Output rotation is directed to the CCW when seeing it from VIEW, the position of output shaft.
<Figure-h>



<Figure-g>



<Figure-h>

4) Handling Precautions

4-1 Storage ⚠ **CAUTION**

In case of keeping it over one month, a clean hydraulic oil (operating oil) has to be injected to the inner case of HST to prevent any possible corrosion of HST inside, and it has to be kept in a dry and clean place.

4-2 Operating Oil (Hydraulic Oil) ⚠ **WARNING**

Oil for operating a hydraulic system affects the performance and service of machinery as to what to choose and handle the oil. In general, an operating oil has to be a quality hydraulic oil and it has to be excellent in its lubrication, oil resistance, oxidative stability, and anti-corrosion. And it has to have properties not to give damage to packing and seal. For this HST, an operating oil of ISO VG46 is highly recommended. In case of mixing with other kind of oil, it has to use a new oil.

4-3 Pollution Management ⚠ **WARNING**

1) HST is to be delivered in a fully washed condition to protect the Main Body of HST. In case of feeding the hydraulic oil (operating oil) into a tank or while using it, you make sure to take a special care not to have any pollution molecules come into the HST. The pollution level of hydraulic oil has to be maintained within NAS9 Level. Pollution molecules of over 100μm can be a main factor that can give a severe damage to the HST for a short time.

4-4 Shaft Coupling ⚠ **WARNING**

1) A special carefulness will be taken when taking out HST Input/Output Shaft and Driving M/C Shaft/Core. The stagger (deflection) of core shall be set within 0.05mm.

2) When attaching/detaching HST to Main Body, an excessive load shall not be given to the end of Output/Input Shaft.

4-5 Defect of lever shaft ⚠ **WARNING**

1) If lever Shaft of HST has an excessive torque beyond its specified value, it is highly likely to be broken. So, Stopper shall be operated less than its maximum inclination angle that HST allows, and a special care is taken not to apply an excessive torque, beyond its specified value, to lever Shaft.

2)A special care is needed not to have rain or water drops fall towards the lever Shaft or Oil Seal; otherwise, lever Shaft gets rusted and oil leakage may happen.

4-6 Starting ⚠ WARNING

1)Fill a hydraulic oil (operating oil) in HST Case.

2) After mounting HST, start to idle the engine, work the pedal of vehicle slowly, and move it forward/backward repeatedly. In this way, air has to be let out of HST.

Failure to let the air out of HST fully results to noise caused by aeration, not by HST. So, you shall continue the above operation procedure until the noise is completely gone.

If there is an excessive inflow or mix of air, Output Shaft of HST may not work its rotation. In this case, place the Lever at its maximum inclination angle from idling rotation of engine temporarily, and it starts to rotate. (In this case, it is safe to jack up a vehicle because a sudden acceleration of vehicle can occur)

3) At first, you shall drive it at a low rotation state. After checking that there is nothing abnormal, such as noise or vibration, you can go up to its specified rotation.

4-7 Oil Temperature Management ⚠ CAUTION

As for hydraulic unit, the most important thing is to how extent a driving temperature is maintained. If it is too high, oxidative resistance of hydraulic oil (operating oil) deteriorates, which leads to the shortening of its service life. On the contrary, if it is too low, its density gets high, which leads to the deterioration of HST's mechanical efficiency. So, users should comply to the following precautions.

1) Starting Temperature

In case that a driving temperature is less than +10˚C, you turn up a heater over +10˚C and start to drive the Main Body.

2) Common Driving Temperature

It is optimal to maintain it within +20˚C~ +60˚C

3) Max. Limit of High Temperature for Driving

Max. limit of driving temperature is 82˚C. This max. limit value is determined by the aging effects of hydraulic oil's density, oxidative resistance, O-ring, and Oil Seal, etc. So, driving at over +82˚C can deteriorate the service life of HST, not to mention the life of oil.

4-8 Piping ⚠ WARNING

1) As for drain pipe of HST, you shall set the size, length and bending of pipe so that internal pressure of HST Case can be less than its value specified in SPECs.

2) Be sure to wash the pipe before assembly, and eliminate scales in the pipe safely.

3) A special care is needed not to have dirty or foreign materials comes into the pipe from inlets of each HST while laying pipe.

5. Regular Check & Replacement Cycle of Hydraulic Oil ⚠ **CAUTION**

Even at the first washing, there may be sedimentation (ex: sludge) in circuit tank while doing a long drive. It can lead to damage of HST, deterioration of hydraulic oil, and malfunction of it.

To prevent these conditions, it is requisite to perform a regular inspection on hydraulic oil and replace with a new one if necessary. It is difficult to indicate the pollution state or deterioration of oil in a quantitative way, but there is an effective method of judging the state by naked eyes. You should refer to the following visual inspection.

But if fifty(50) hours or more pass after factory shipment, it shall be replaced with a new one upon the earlier of once a year (after starting to use it that year) or 200Hrs.

When replacing with a new hydraulic oil, there is mixture of deteriorated oil, sludge, and water, etc in the tank, which may result in poor performance of HST and shorten its service life. So, it is requisite to flush the internal of machine before making replacement of oil.

※ Visual Inspection & Judgment
(Take the sample of oil from HST Case, put it in a test tube, and compare it with a new hydraulic oil)

Appearance	Smell	Condition	Action
Transparent, and no discoloration	Normal (Good)	Good	Usable
Transparent, and small black spots	Normal (Good)	Foreign materials are contained.	Filter out the foreign materials, and use it.
It is discoloring into milk-white color	Normal (Good)	Moisture (water) is contained	Replace with a new oil
It has been discolored into black.	Stink	Oxidized and aged	Replace with a new oil

1. HYDROSTATIC PEDAL AND NEUTRAL ADJUSTMENT

Reason:
To ensure that tractor does not move unless the forward or the reverse pedal is depressed.

Procedure:
1.Operate the hydrostatic control pedals. They should return by themselves to the neutral position.
If pedals do not operate properly, check pedals and linkage for damage or wear.
2.Start engine and run at low idle and then maximum rpm.
3.Place range shift lever in LOW gear and Hi gear. Tractor should not move.
If tractor moves, note direction and adjust neutral return linkage as follows:

Note :
In case of moving to forward a little, neutral lever comp(B) turns towards backward direction slightly(CCW).
In case of moving to backward a little, neutral lever comp(B) turns towards forward direction slightly(CCW).

Note :
Service of the neutral setting of HST unit should be performed following the instructions on the page 2-10, 2-11 and 2-12 (2) Installation in the paragraph :
4 SEPARATION OF THE FRONT AXLE BRACKET AND TRANSMISSION.

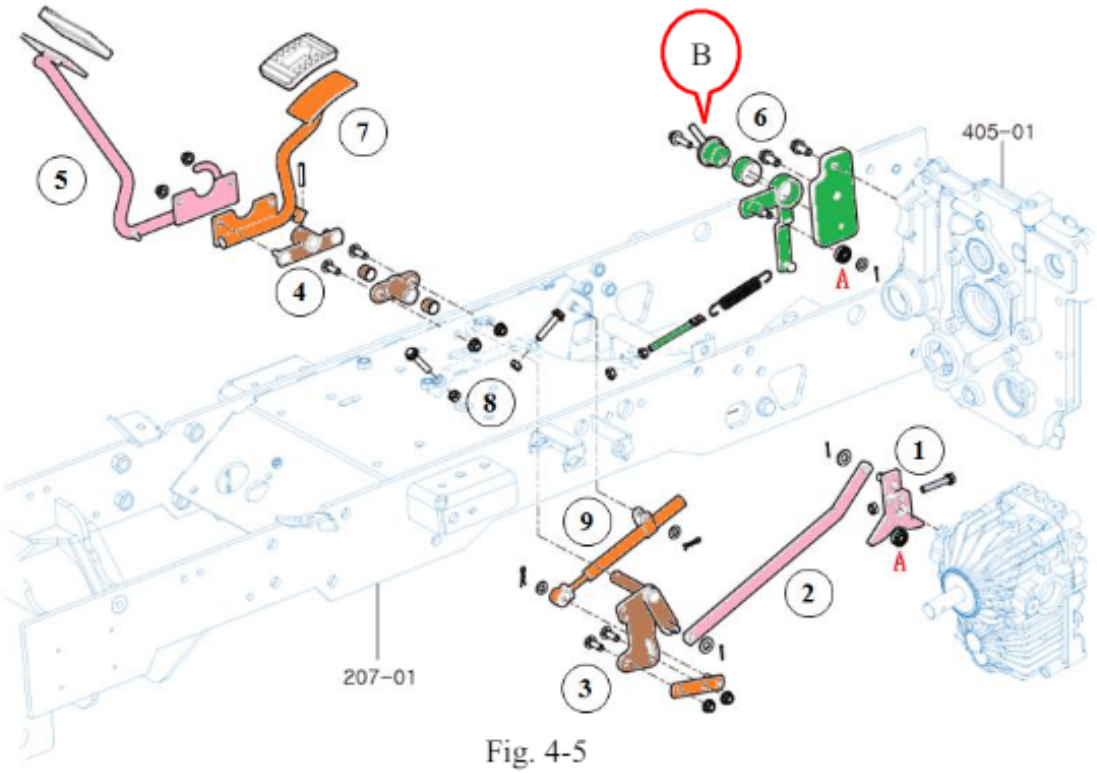


Fig. 4-5

1. Holder comp
2. Control rod assembly
3. Pedal shaft comp.
4. Arm comp.
5. Forward pedal comp
6. Neutral arm comp
7. Reverse pedal comp
8. Stopper comp
9. Damper , oil

2. HYDROSTATIC PUMP PRESSURE TEST

Reason:

To ensure that internal parts of the hydrostatic pump are not worn excessively, and the relief valves are operating properly.

Equipment:

①Gauge spec. : Over 500 kgf/cm² (6,610 psi)
②Coupler spec. : 3/8"(Hose with quick coupler)
③Adaptor spec. : UNF3/4-16 and 1/2-20

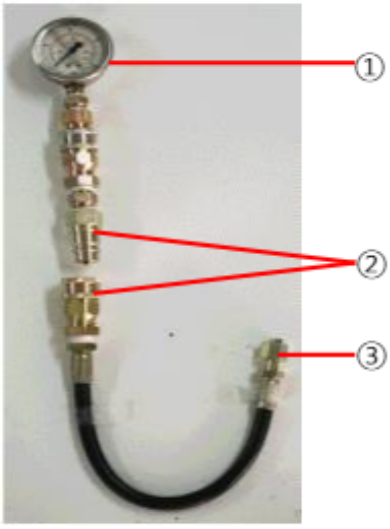


Fig. 4-6

IMPORTANT : Make sure that the hydraulic fluid is visible in sight glass. Insufficient hydraulic fluid could cause system to run dry and damage pump and motor.

IMPORTANT : Do not allow valves to relieve for more than 10 seconds or hydraulic oil may overheat.

Procedure:

1.Park tractor on a level surface
2.Turn key switch to OFF position.
3.Make sure range transmission shift lever is in neutral position.

⚠ CAUTION

AVOID SUDDEN TRACTOR MOVEMENT.Tractor could move suddenly causing severe injure or damage to equipment during test procedure. Perform test in open area.keep all personnel away from front or rear of tractor

4.Start engine and run until hydraulic oil is warm.
5.Stop engine.
6.Cycle all controls to relieve any pressure that may be in the hydraulic system

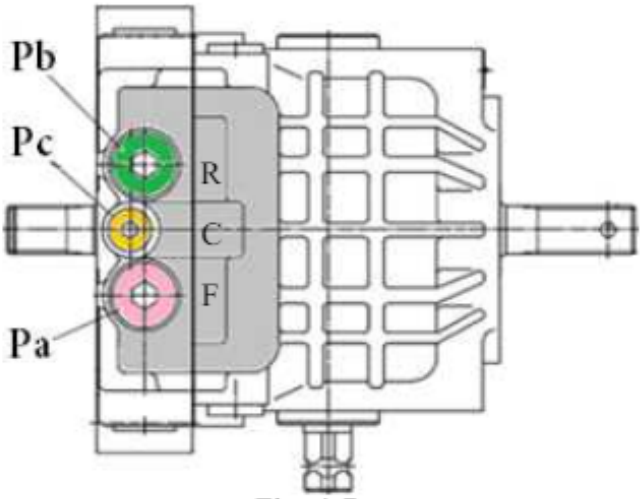


Fig. 4-7

7.Locate test ports on hydrostatic transmission inside tunnel opening.
8.Remove test port plugs.
9.Install ③adaptor male into each test port.
10.Attach ②gauge and hose assembly as shown each test port adapter.

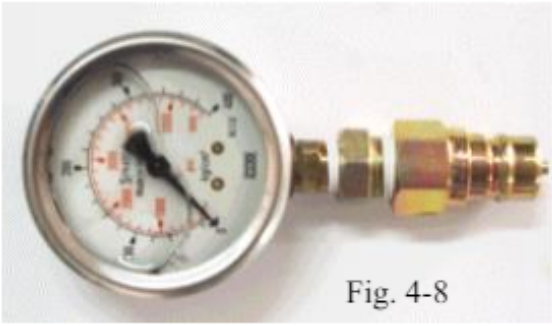


Fig. 4-8

11.Position gauges so they can be read from tractor's side.
12.Perform test from tractor's side.
Make sure that the parking brake is engaged.
Place range shifting lever in neutral position.
Start engine and run at full throttle.

⚠ CAUTION

If brake fail to prevent wheels from turning. STOP TEST IMMEDIATELY.Repair or adjust brakes are necessary before resuming test. (See brake section)

13.Slowly depress forward directional pedal and observe gauge. Gauge should slowly rise to approximately 180~210kgf/cm² and relief valve will open with an audible squealing noise if there is a filter plugging or an insufficient supply of oil. (at the Pa port)

14.Repeat same procedure with reverse pedal. (at the Pb port)
Specifications : Pump pressure should reach approximately 180~210kgf/cm² in either direction and then relieve.

Results:
-If pressure will not reach 180~210kgf/cm² in either direction, check charge.
Pressure.
(SEE "CHARGE PUMP PRESSURE TEST)
-If charge pressure is good and hydrostatic pump pressure will not get up to relief pressure hydrostatic pump is worn or damaged.
-If pressure reaches 180~210kgf/cm² in one direction and not the other, one of the relief valves is defective or the seat is leaking.

3.CHARGE PUMP PRESSURE TEST

Reason:

To ensure that charge pump is operating at specified pressure to supply oil to hydrostatic pump.
Equipment :

Fig. 4-9

Procedure:
1.Park tractor on a level surface and set park brake.
2.Turn key switch to OFF position.
3.Shift transmission to NEUTRAL.

IMPORTANT : Make sure to relieve system pressure before loosening any system lines or hoses.

4. Cycle all controls to relieve any pressure that may be in the hydraulic system.

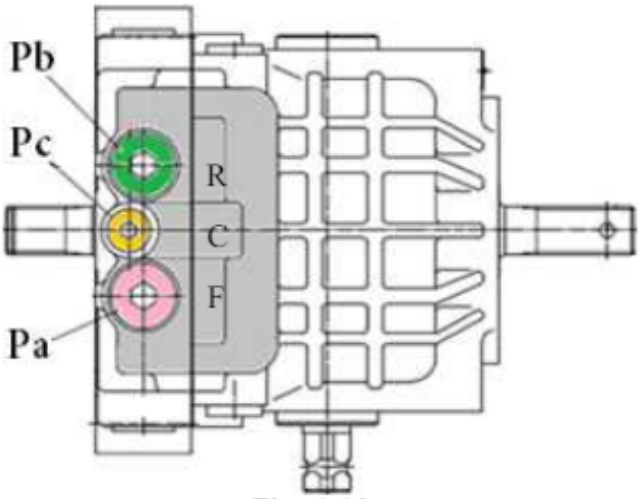


Fig. 4-10

5.Underneath the seat bracket, at the front of the tunnel, locate the hydrostatic transmission, Remove the plug in the charge pressure test port.
6.Assembled test equipment as shown and install to test port.
7.Start engine and run at high idle (2000~3000rpm)
8.Check pressure reading gauge.

Specifications : at the Pc port
Charge Pressure : 9~10kgf/cm², at neutral position or reverse position with 180~210 kgf/cm².

Results : Charge pressure should reach 9~10kgf/cm² (113~142psi). Can not be obtained ; the mesh inlet filter may be restricted, the suction line may be restricted or leaking air, or front hydraulic pump may be defective.

4. HYDRAULIC SYSTEM BLEED PROCEDURE

Reason:

To remove air trapped in the hydraulic system which will prevent proper operation.

Procedure:

IMPORTANT : If contamination is found in hydraulic system filter or inside reservoir, flush entire hydraulic system.

NOTE : Fill the hydraulic oil filter with new oil before installing.

1.Install a new hydraulic oil filter.

2.Fill the transaxle with specified and recommended transmission oil to the proper level in sight glass.

3.Turn the key to the glow position to heat the combustion chamber in the engine.

4.Turn the key to START. And turn the key to OFF.

5.Raise tractor front end and support on suitable stands.

6.Start the engine and run at low idle.

IMPORTANT :

If steering fails to respond, or pump pressure is not being delivered to steering control unit (SCU), shut engine off and check to see that steering hoses are connected to the correct SCU ports.

7.Slowly turn the steering wheel left and right until wheels turn smoothly indicating that any trapped air has been bled back to the reservoir.

IMPORTANT :

If rock shaft fails to react to lift control lever movement, shut engine off and check hose clamps on suction tube elbow and manifold to ensure that they are properly tightened.

8.Operate rockshaft several times until it operates smoothly.

9.Stop the engine and check the hydraulic reservoir oil level. Fill as needed. Check all line connections for leaks; tighten if necessary.

10.Lower the tractor to the ground.

11.Drive tractor in forward and reverse several times until transmission operates smoothly.

1. HYDROSTATIC SPLITTING.

Prepare the Tractor:

1. Park tractor on a level surface.
2. Shut off engine.
   Release hydraulic pressure by operating all controls.
3. Remove the dash panel cover.
4. Disconnect battery negative terminal.
5. Drain the oil in transmission case through the drain plug.
6. Remove the slow control grip and mower adjustment knob and seat assembly.
7. Remove the floor panel and mat.
8. Remove the ROPS and floor panel seat.

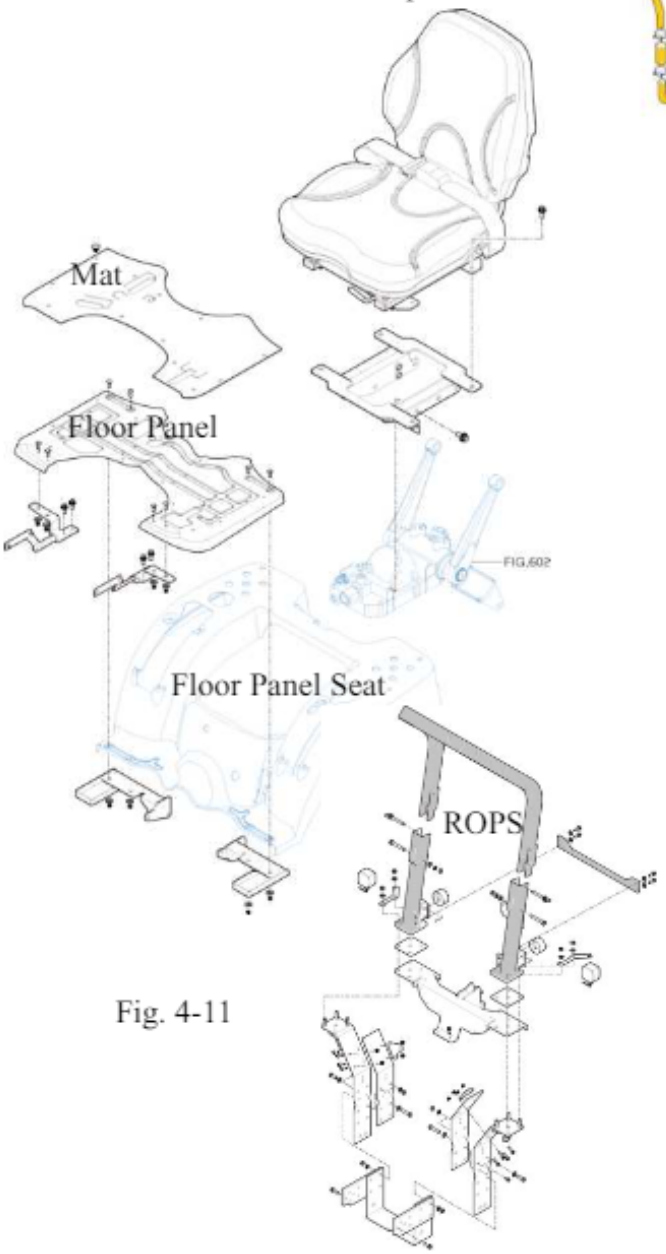
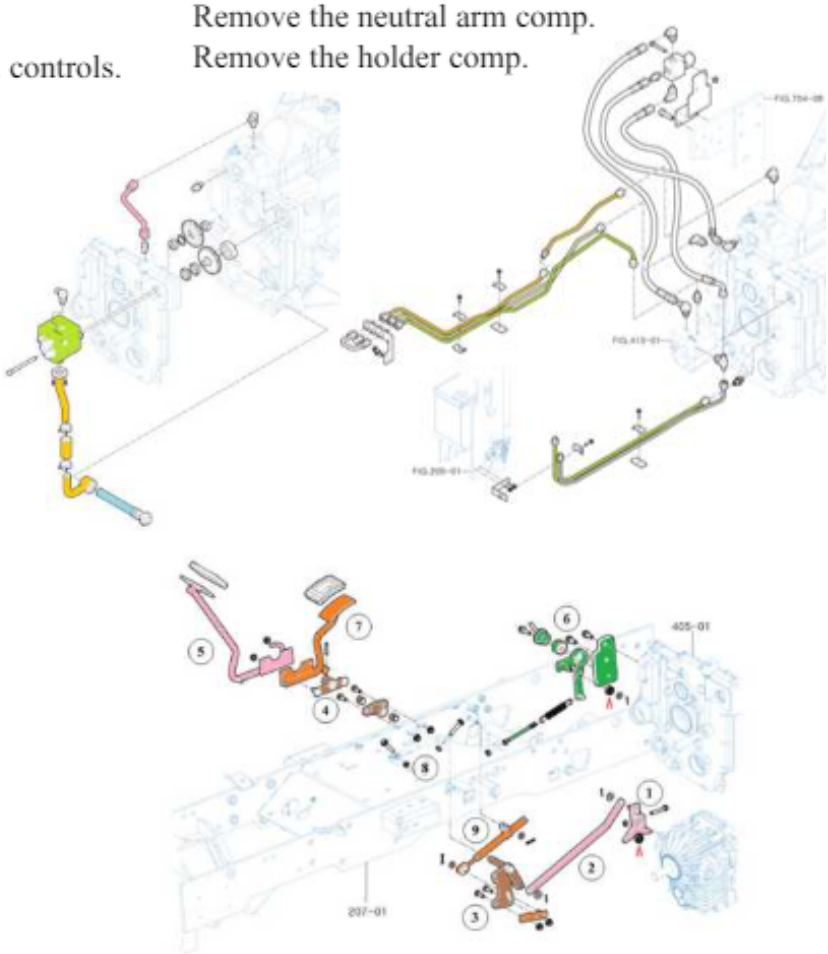


Fig. 4-11

9. Remove the hydraulic pipes and gear pump.
   Cut the clamps.
   Disconnect the wiring harness.
   Remove the neutral arm comp.
   Remove the holder comp.



1. Holder comp
2. Control rod assembly
3. Pedal shaft comp.
4. Arm comp.
5. Forward pedal comp
6. Neutral arm comp
7. Reverse pedal comp
8. Stopper comp
9. Damper , oil

Fig. 4-12

9. Remove the drive shaft.
   Remove the HST unit.

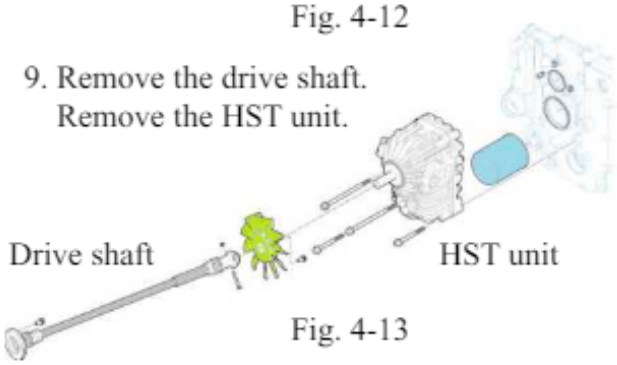


Fig. 4-13

Note : Oil may drain from the HST unit after it is removed. Have a suitable container ready to catch the excess oil.

Note : Be careful not to damage the filter and O-rings and lock pin.

Note : Hydraulic transmission weights approx. 12 Kg. Attach a suitable lifting device to transmission before removing screws.

Installation :
Install the reverse order of disassembly.

1) Clean the surface of input metal before installing the O-Rings.
2) Apply grease or gear oil to O-rings.
3) Tighten the screws attaching hydrostatic unit to the input metal to specified torque.

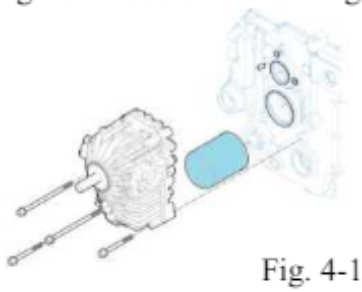


Fig. 4-14

Tightening torque	
2xM8x1.25-140L (11T) 2xM8x1.25-75L (11T)	1.7 ~ 2.2 Kgf.m (12 ~ 16lb.fts)

Note : If neutral adjustment locking screws were loosened, neutral adjustment procedure must be performed.
See "HYDROSTATIC PEDAL AND NEUTRAL ADJUSTMENT" in page 4-15.

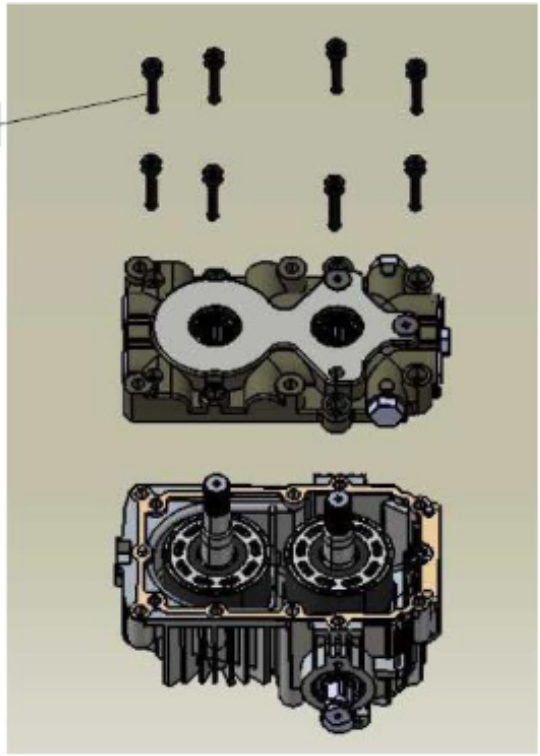
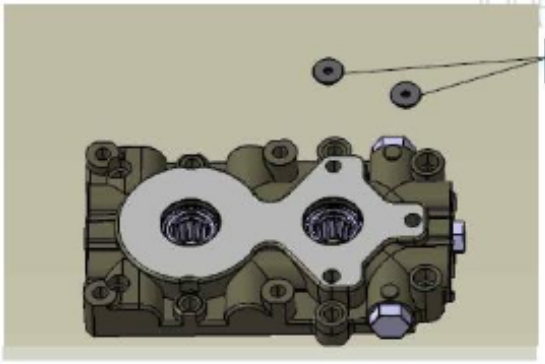
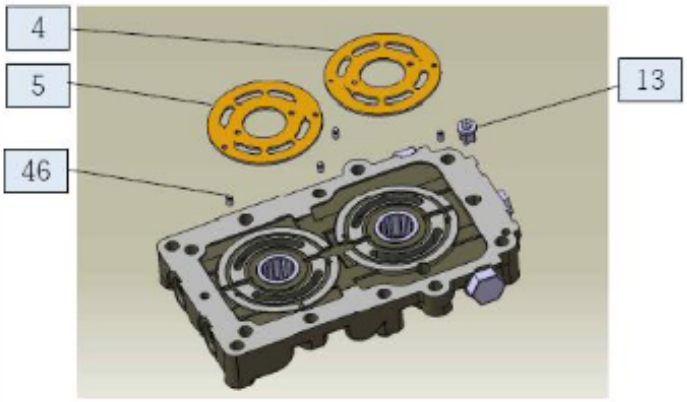
2. HYDROSTATIC OVERHAUL.

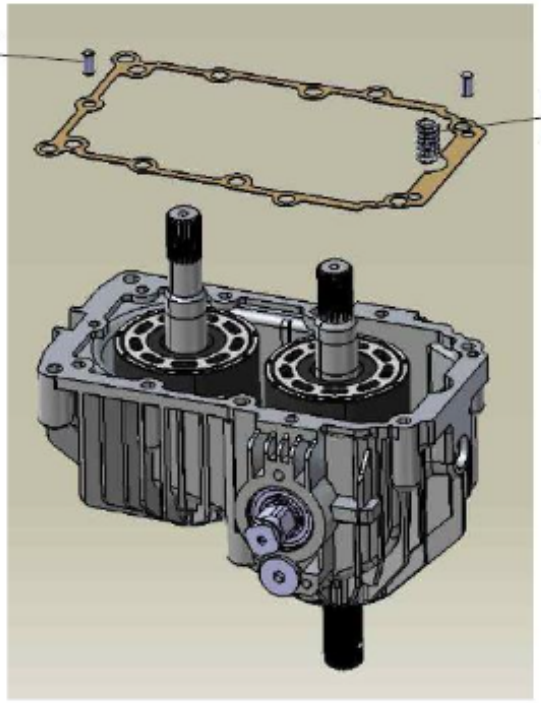
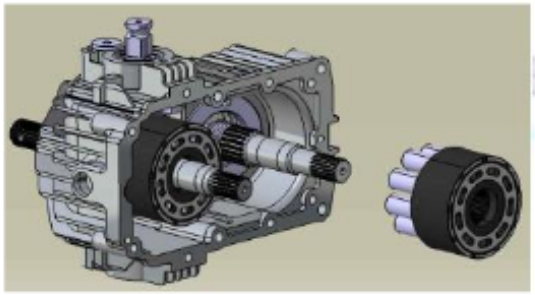
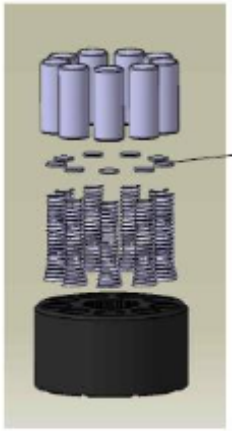
1. Tools

No.	Tool Name	Size & Set Value
1	Rubber hammer	
2	Driver(-)	150mm
3	Snap ring plier (For inner hole)	R-
4	Snap ring plier (For shaft)	S-
5	Torque wrench	400 kgf.cm , 800kgf.cm
6	Socket wrench	22 mm
7	L wrench	6 mm
8	Hexagonal wrench	6 mm
9	Spanner	14

2. Pre-Disassembly Precautions

a. Make sure to remove dirt or foreign materials from the outside surface.
(Make sure to wash the outside surface fully. When doing this job, it is important to close lids so that dirt or foreign materials cannot comes into each port).
b. Discharge a hydraulic oil (Operating oil) out of its case.
c. Keep working site clean and tidy, and be fully careful not to have any dirt or foreign materials come into each part.
d. Take a special care to prevent any possible falling of parts and puncture damage caused by contact.
e. For each Part Number stated in Assembly Manual, see the assembly drawing attached in Figure 35, 36.

PROCESS DRAWING	DESCRIPTION
 (Figure-1)	1.Take off VALVE CASING. a. Loosen SOCKET BOLT(45)[M8x40L]8pcs. b. Take off VALVE CASING(ASS'Y). Refer (Figure-1) ☆Be careful not to drop VALVE PLATE. ☆Be careful not to lift it with CYL'D BLOCK. ☆PIN(46) may come off. In case that CYL'D BLOCK is not separated, Disjoin by Open a gap of VALVE CASING and CYL'D BLOCK.
 (Figure-2)	2.Disassemble VALVE CASING a. Take off RUBBER PLUG(47) from VALVE CASING(3). Refer (Figure-2)
 (Figure-3)	b. Disjoin CHECK(CHARGE)(13). c. Disjoin VALVE PLATE(4),(5). d. Disjoin PIN(46). Refer (Figure-3)

PROCESS DRAWING	DESCRIPTION
 (Figure-4)	3.Disjoin CYL'D BLOCK a. Take off GASKET, PIN(14), SPRING(CHARGE)(20) Refer (Figure-4)
 (Figure-5)	b. Take off CYL'D BLOCK ASS'Y(Motor side) Refer (Figure-5)
 (Figure-5a)	! Be careful not to lost WASHER(24). Refer (Figure-5a)

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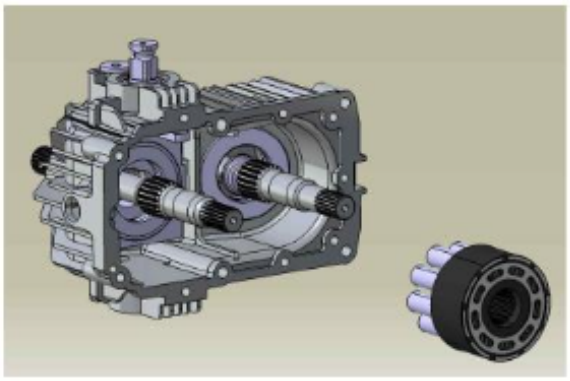
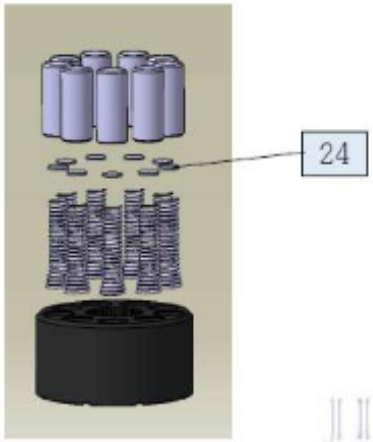
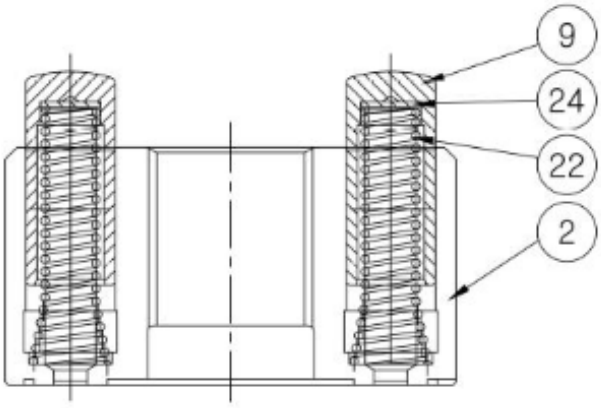
PROCESS DRAWING	DESCRIPTION
 (Figure-6)	c. Take off CYL'D BLOCK ASS'Y(Pump Side) Refer (Figure-6)
 (Figure-6a)	! Be careful not to lost WASHER(24) Refer (Figure-6a)
 (Figure-6b)	4.COMPONENTS OF CYL'D BLOCK ASS'Y (COMMON FOR PUMP, MOTOR) (9) PISTON 18PCS (24) WASHER 18PCS (22) SPRING 18PCS (2) CYLINDER BLOCK 1PC Refer (Figure-6b)

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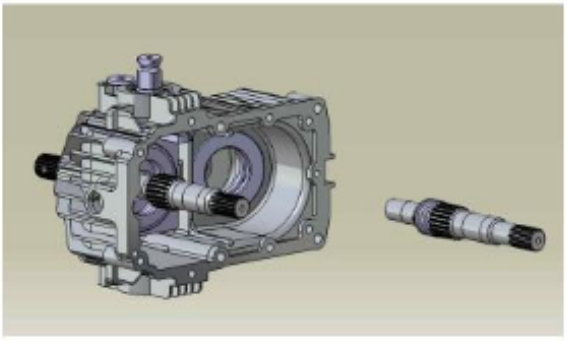
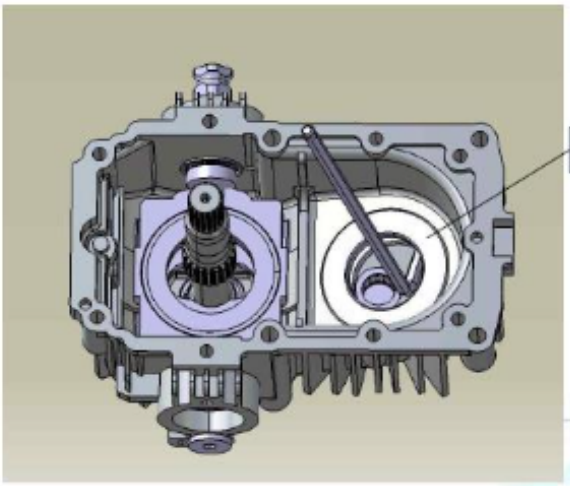
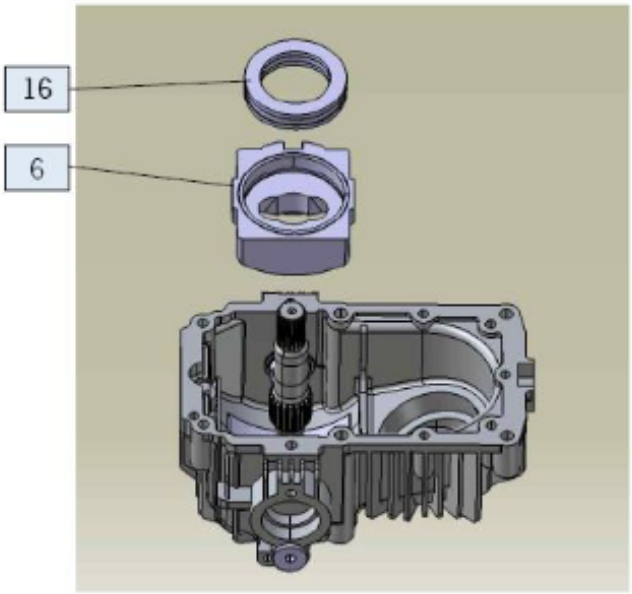
PROCESS DRAWING	DESCRIPTION
 (Figure-7)	5.Separate SHAFT(M) Refer (Figure-7)
 (Figure-8)	6.Disjoin THRUST BALL BEARING(15)(Motor side) a. Using the principle of leverage, separate THRUST BALL BEARING(15) with L-WRENCH Refer (Figure-8)
 (Figure-9)	7.Separate THRUST ROLLER BEARING(16) (Pump Side) and SWASH PLATE(6) Refer (Figure-9)

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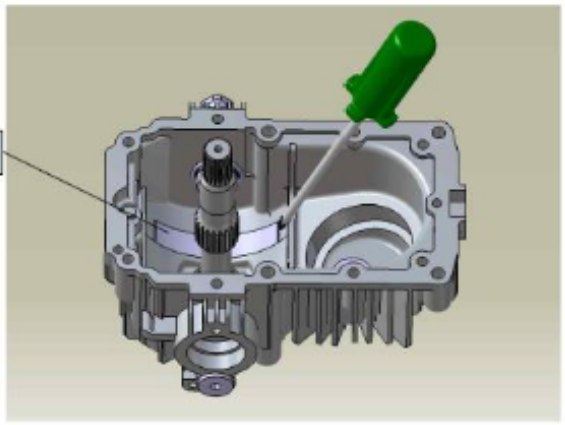
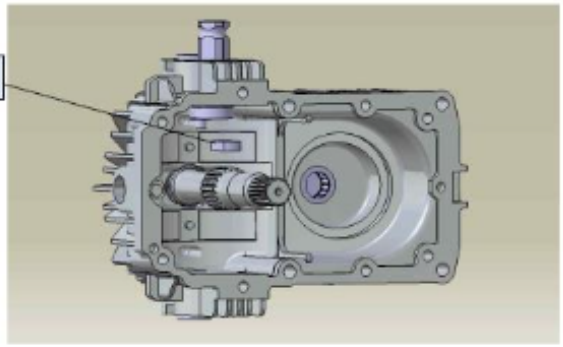
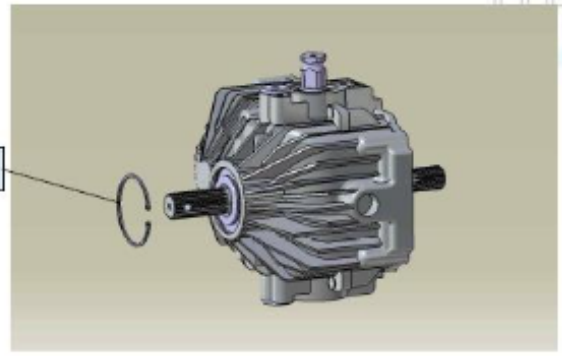
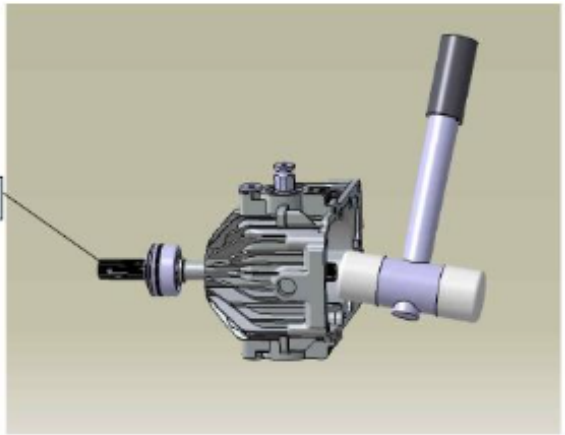
PROCESS DRAWING	DESCRIPTION
 (Figure-10)	8.Separate DRY BEARING(19) with a driver(-) Refer (Figure-10)
 (Figure-11)	9.Separate THROTTLE GUIDE(12). Refer (Figure-11)
 (Figure-12)	10.Separate SNAP RING(39)(Pump side). Refer (Figure-12)
 (Figure-13)	11.Separate SHAFT(P)(7) ASS'Y with a Rubber Hammer. Refer (Figure-13) refer

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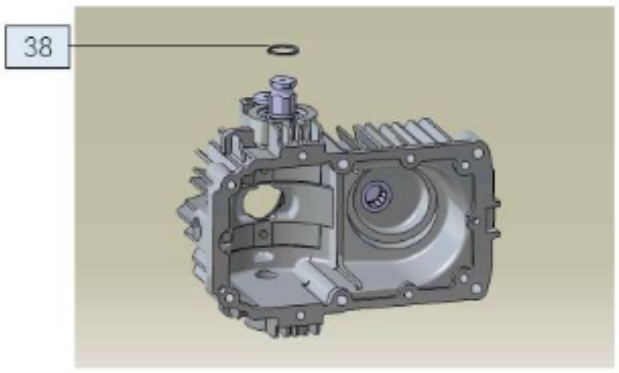
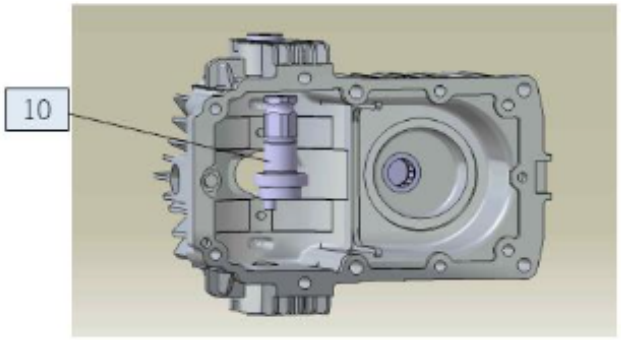
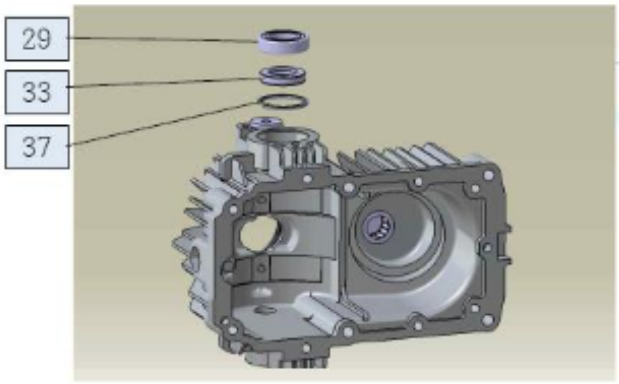
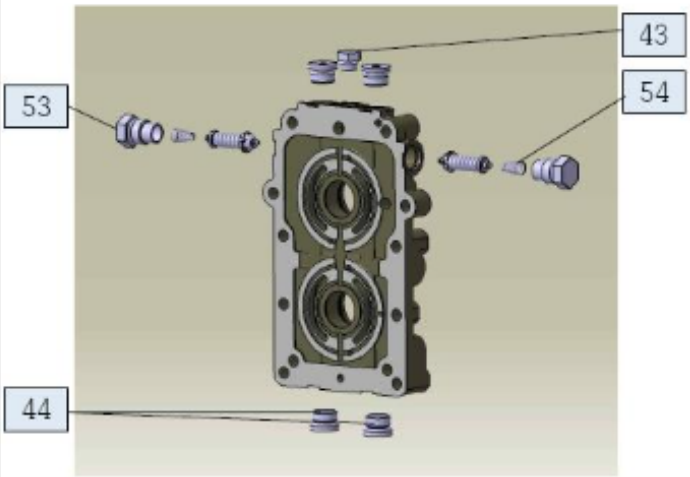
PROCESS DRAWING	DESCRIPTION
 (Figure-14)	12.Separate SNAP RING(38)(LEVER Side) Refer (Figure-14)
 (Figure-15)	13.Separate LEVER(10). Refer (Figure-15)
 (Figure-16)	14.Separate BALL BEARING(29), OIL SEAL(33), SNAP RING(37). Refer (Figure-16)
 (Figure-17)	15.Disassemble VALVE CASING PLUG(44)[UNF3/4-16]4pcs, PLUG(43)[UNF1/2-20]1pcs, Loosen PLUG(53)[UNF3/4-16 Relief]2pcs, take off SPRING(RELIEF PLUG)(54)2pcs and then separate RELIEF ASS'Y. Refer (Figure-17)

4. Pre-Assembly Precautions

a) Wash each part with a cleaning (washing) oil and dry it with a clean air.

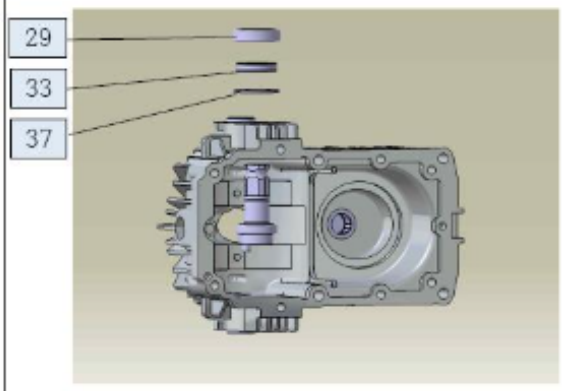
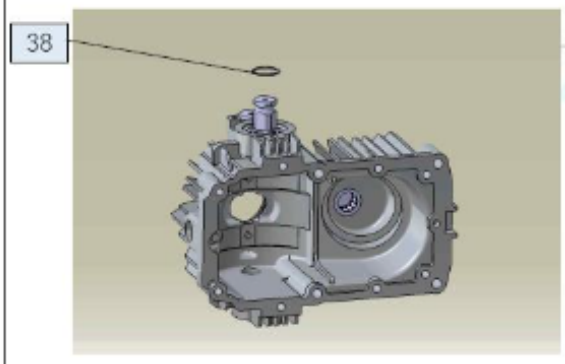
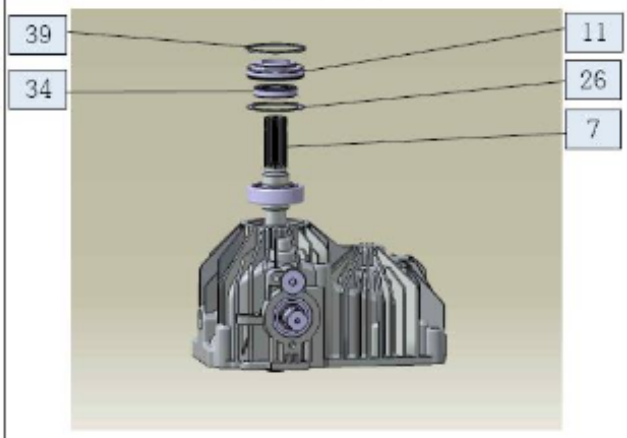
b) Take a special care in handling each part to prevent stain by dirt or foreign materials, and any possible puncture, traces of holes or any other physical damage.

c) Replace seals with new ones.

d) Use a specified fastening torque when tightening each part.

e) Spread Lithium Grease on oil seal and O-ring beforehand.

5. Assembly Procedure

PROCESS DRAWING	DESCRIPTION
 (Figure-18)	16.Assembly of LEVER. a) Assembly of BALL BEARING(29), OIL SEAL(33), SNAP RING(37) b) Assembly of LEVER ASS'Y. Refer (Figure-18)
 (Figure-19)	17.Assembly of SNAP RING(38). Refer (Figure-19)
 (Figure-20)	18.Assembly of SHAFT(P) a) Press-fit OIL SEAL(34) to REAR COVER(P)(11) Take a special care to prevent any possible falling of damage OIL SEAL. b) After assembling SHAFT(P)(7) put together WASHER(REAR COVER)(26). c) After assembling SEAL COVER ASS'Y, put together SNAP RING(39). Refer (Figure-20)

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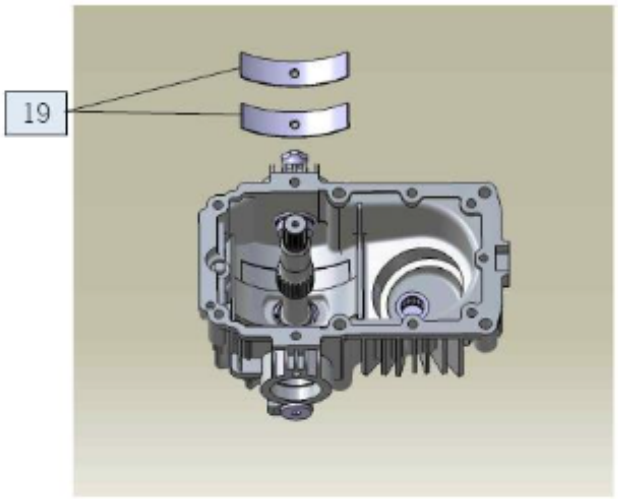
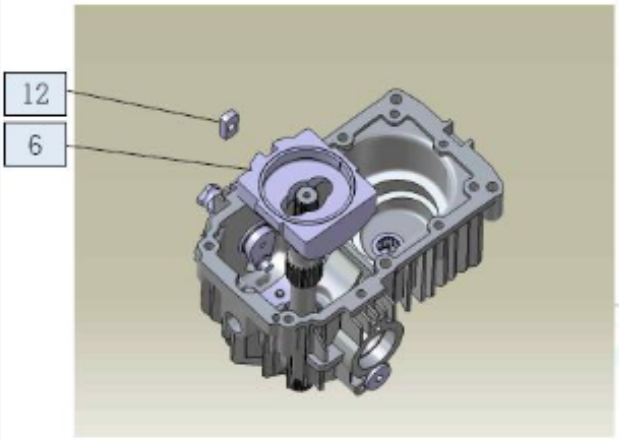
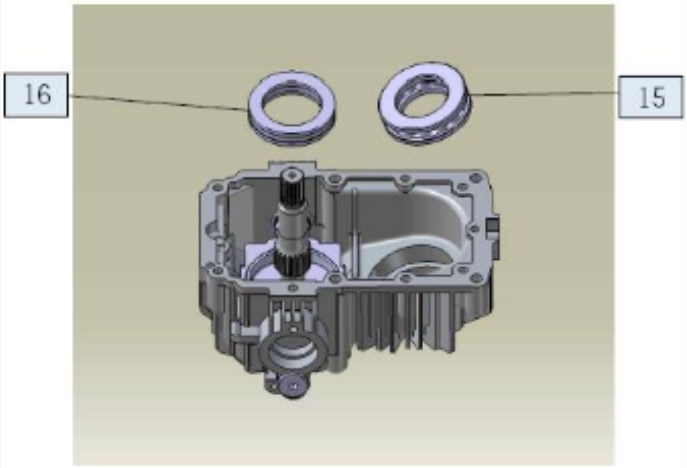
PROCESS DRAWING	DESCRIPTION
 (Figure-21)	19.Assembly of DRY BEARING(19). Refer (Figure-21)
 (Figure-22)	20.Assembly of SWASH PLATE. a) Assembly of THROTTLE GUIDE(12). (LEVER side) b) Adjust SWASH PLATE(6)to the hole and assemble Refer (Figure-22)
 (Figure-23)	c) Assembly of THRUST ROLLER BEARING(16) with BEARING PLATE BEARING PLATE is large and think inner diameter BEARING PLATE is downward. d) Assembly of THRUST BALL BEARING(15) BEARING PLATE is large and think inner diameter BEARING PLATE is downward. Refer (Figure-23)

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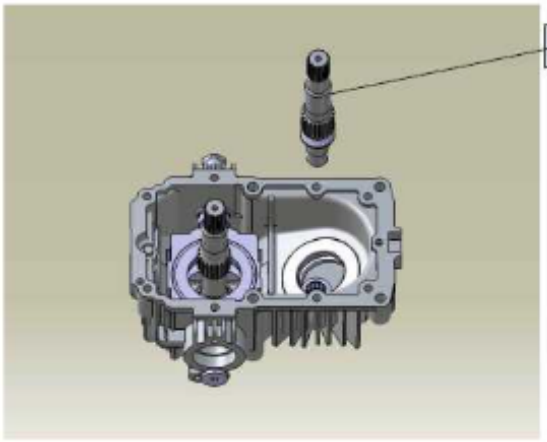
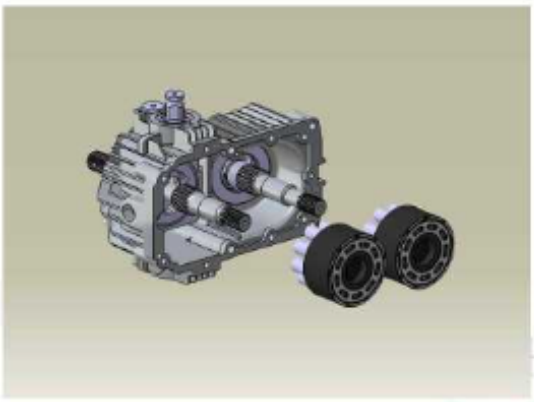
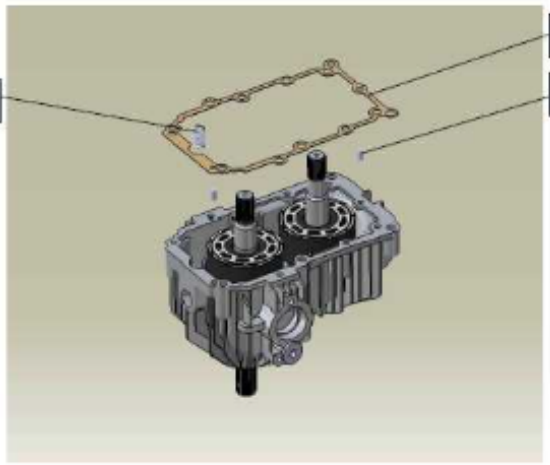
PROCESS DRAWING	DESCRIPTION
 (Figure-24)	21.Assembly of SHAFT(M)(8). Refer (Figure-24)
 (Figure-25)	22.Assembly of CYL'D BLOCK ASS'Y. Refer (Figure-25)
 (Figure-26)	23.Assembly of GASKET. a) Assembly of PIN(14). b) Fit GASKET(17) in PIN. c) Assembly of SPRING(CHARGE)(20). d) Apply a operating oil(hydraulic oil) enough on the sliding face of CYL'D BLOCK Refer (Figure-26)

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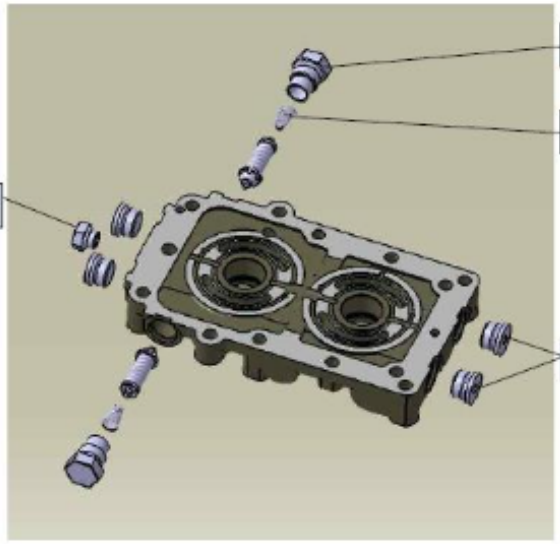
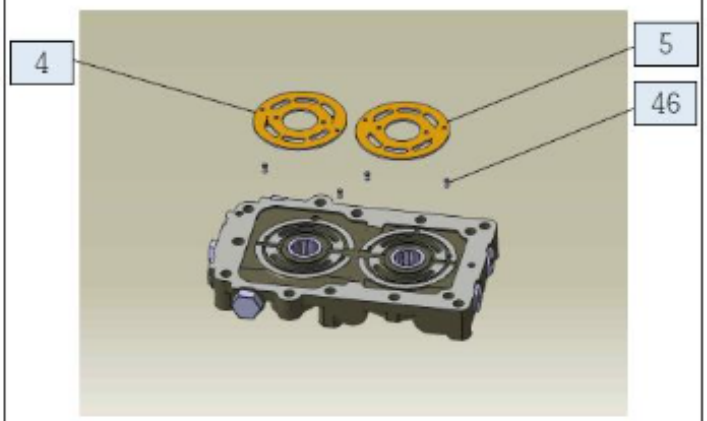
PROCESS DRAWING	DESCRIPTION
 (Figure-27)	24.Assembly of VALVE CASING ASS'Y. a) Assembly of PLUG(44)[UNF3/4-16]4pcs. b) Assembly of PLUG(43)[UNF1/2-20]1pcs. c)After assembling RELIEF ASS'Y put together SPRING(RELIEF PLUG)(54)2pcs and then PLUG(53)[UNF3/4-16 RELIEF]2pcs. Refer (Figure-27)
 (Figure-28)	d)Join them with TORQUE WRENCH. TORQUE : (800kgf/cm) Refer (Figure-28)
 (Figure-29)	e) Assembly of PIN and VALVE PLATE. Be careful not to lost PIN(46). Apply grease lightly on VALVE PLATE (4), (5) and assembly them. When assembly of VALVE PLATE(4), (5) adjust them to the position of PIN. Refer (Figure-29)

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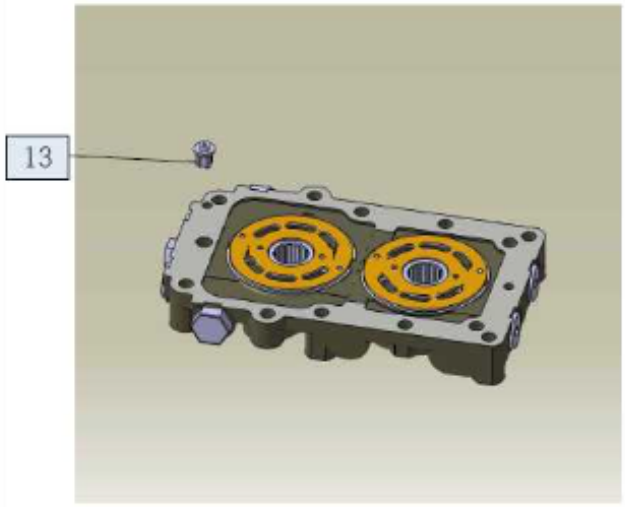
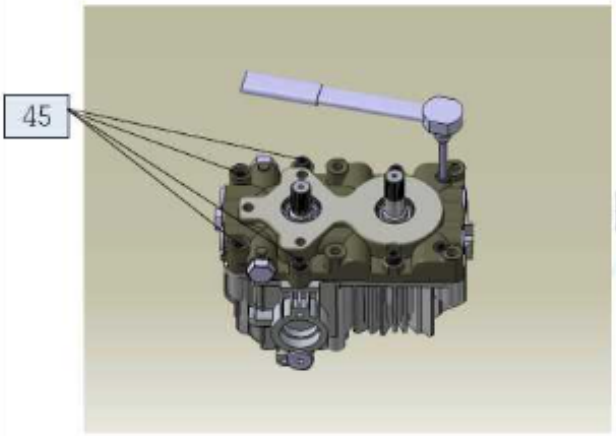
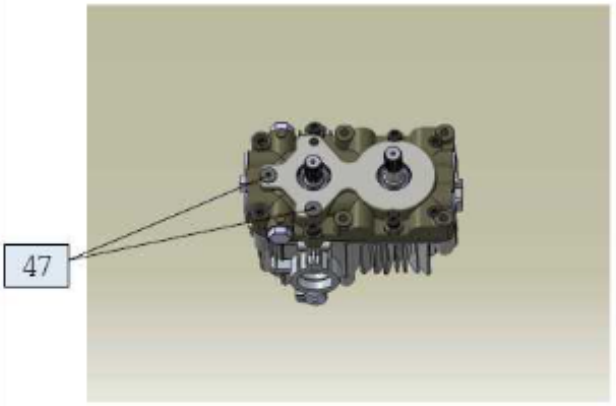
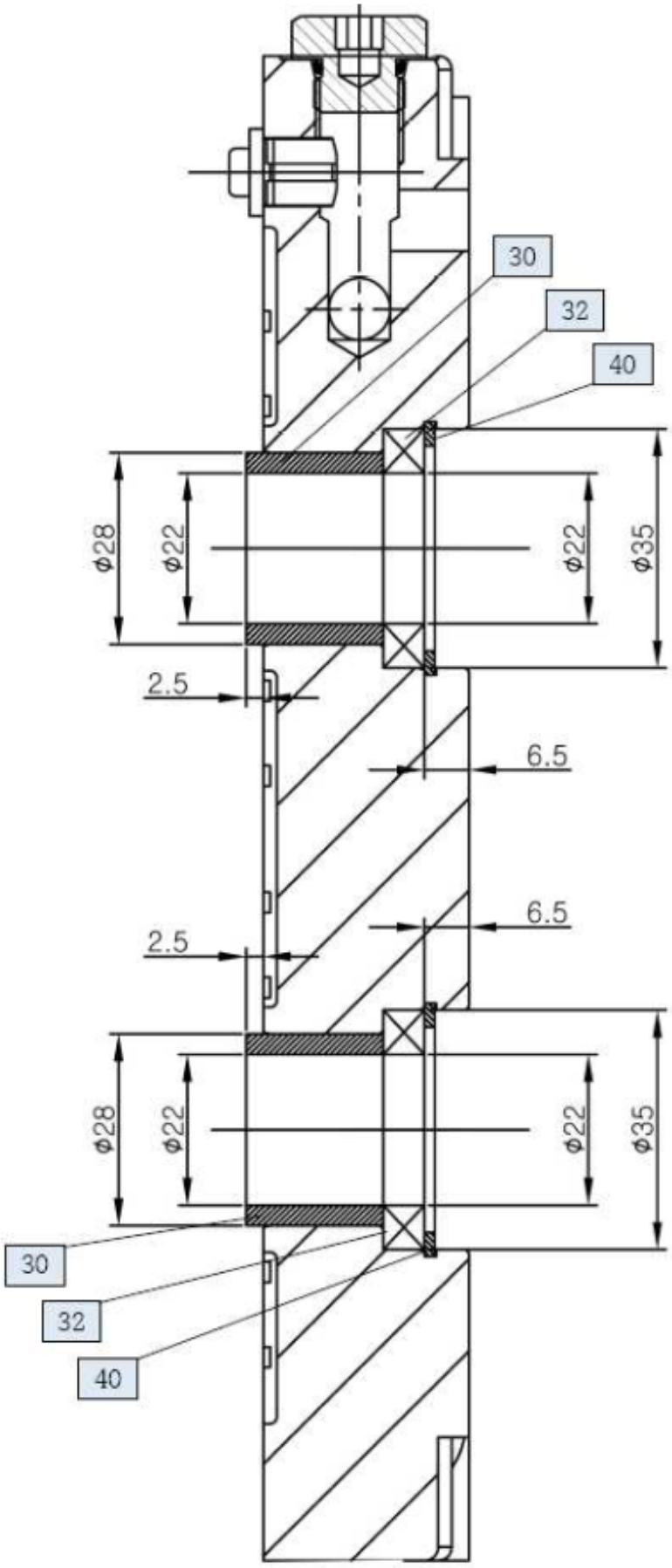
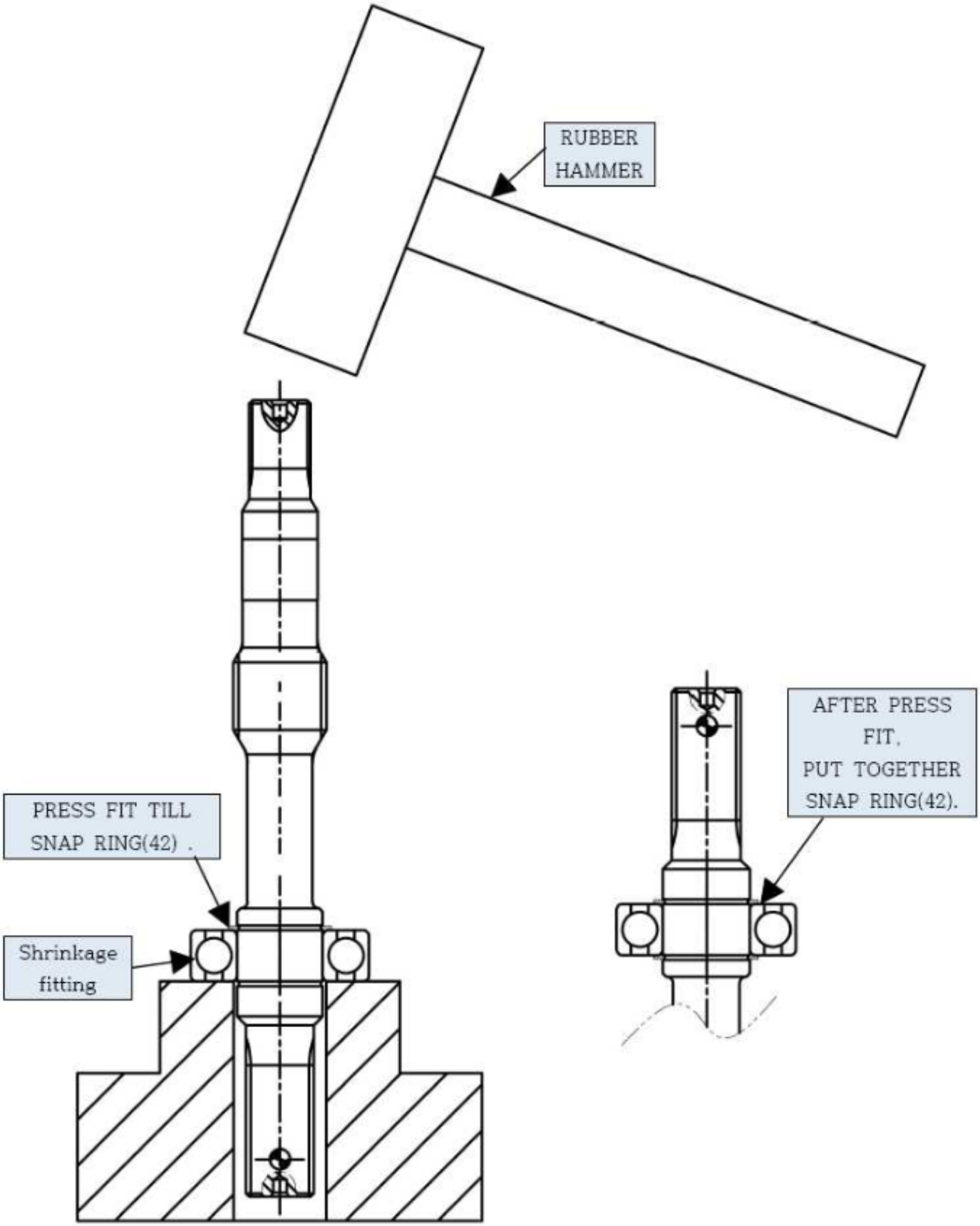
PROCESS DRAWING	DESCRIPTION
 (Figure-30)	f) Apply a grease lightly on the it and Assembly of CHECK(CHARGE)(13). Refer (Figure-30)
 (Figure-31)	25.Assembly of MAIN CASING ASS'Y and VALVE CASING ASS'Y. a) Join SOCKET BOLT(45)[M8x40L]8pcs with TORQUE WRENCH. TORQUE : (400kfg/cm) Refer (Figure-31)
 (Figure-32)	b)Assembly of RUBBER PLUG(47)2pcs. Refer (Figure-32)

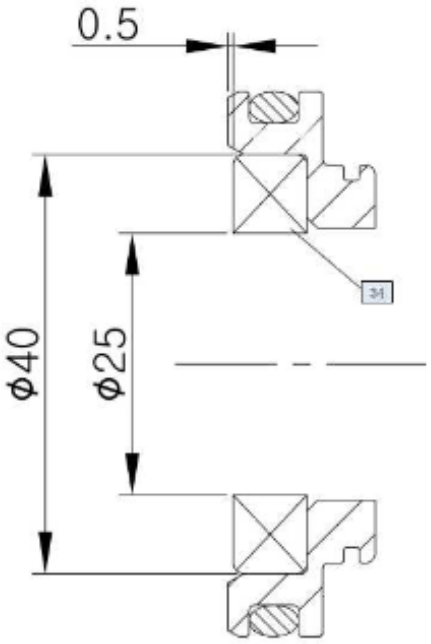


(Figure-33)PRESS-FITTING PART OF VALVE CASING

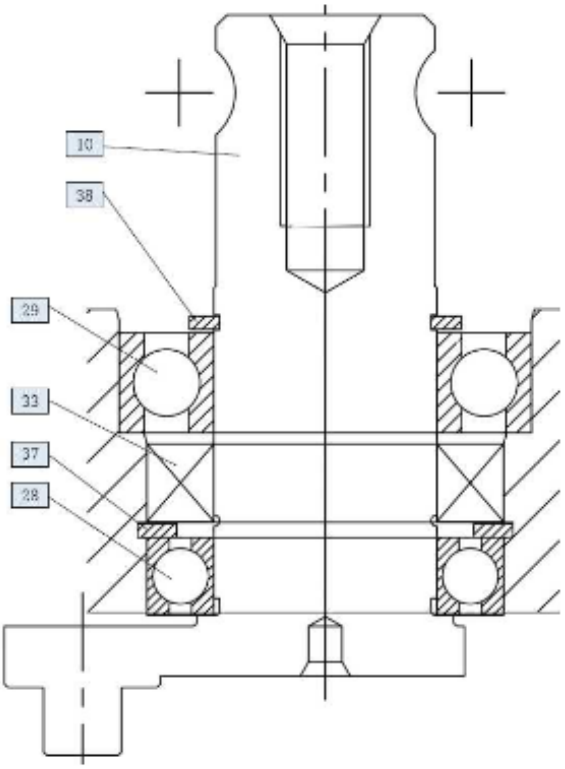
a)Install the NEEDLE BEARING that LOT NO. is shown



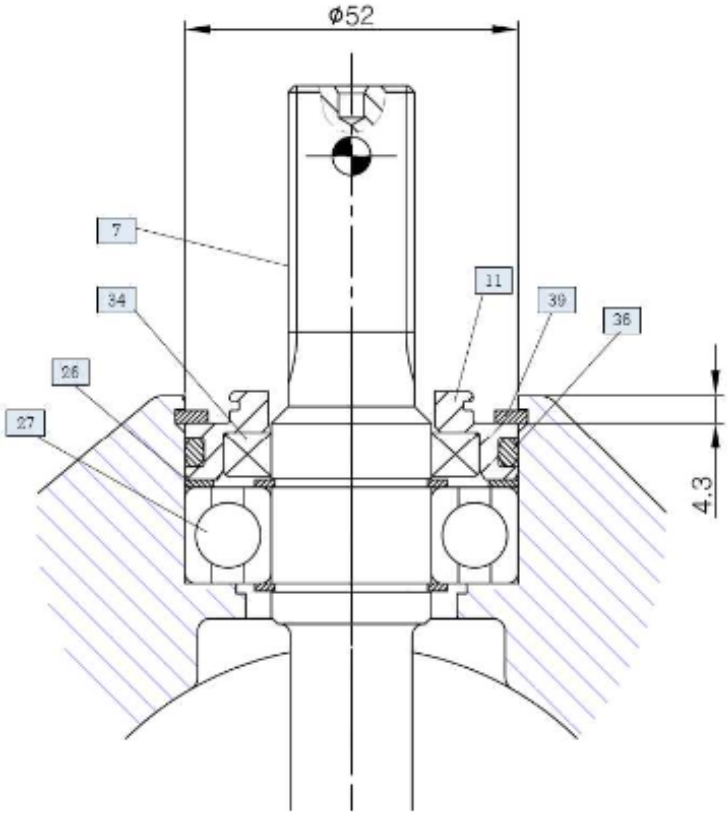
(Figure-34) PRESS-FIT SHAFT(P) BEARING



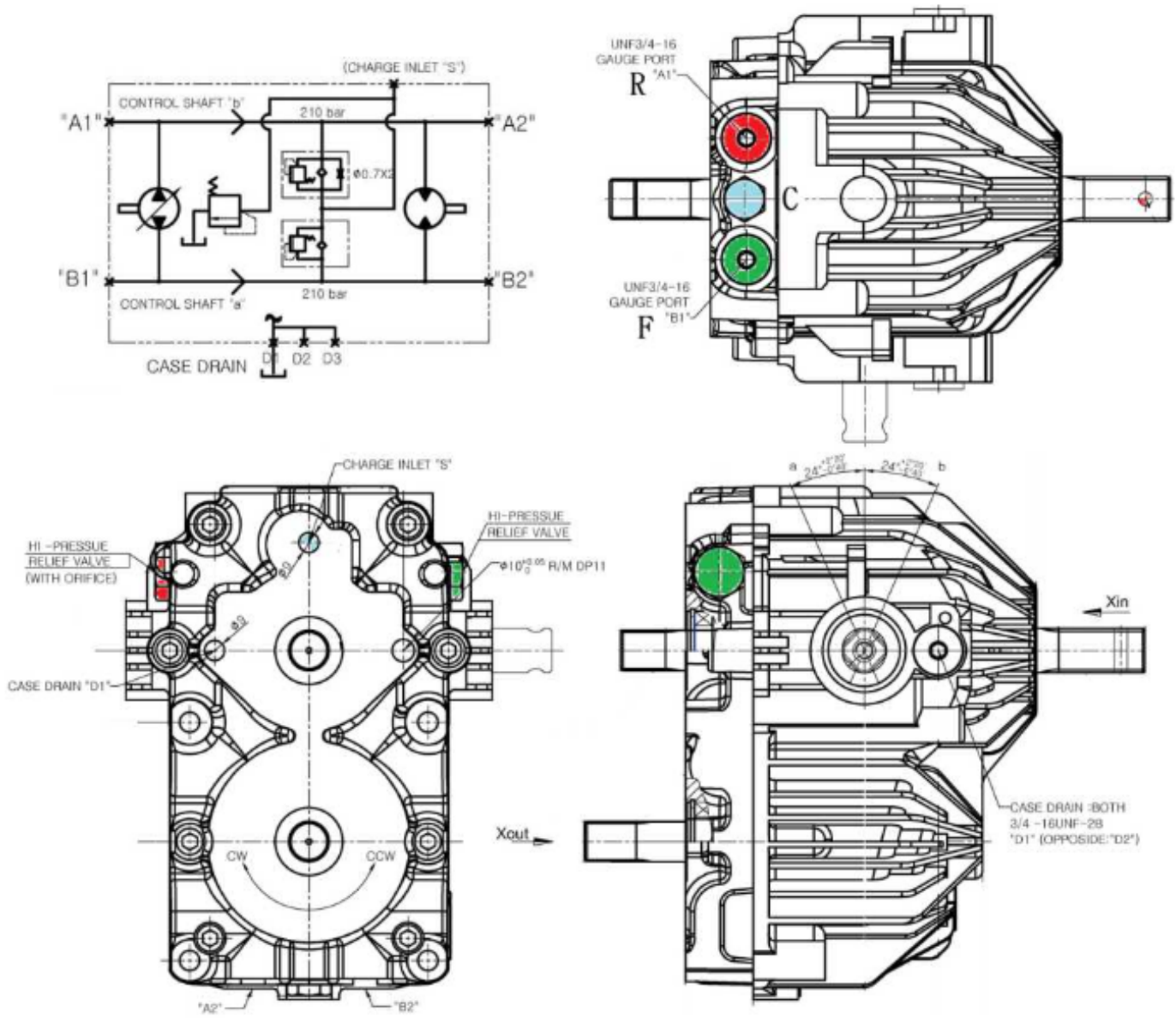
(Figure-35) PRESS-FITTING PART OF REAR COVER(P)



(Figure-37)LEVER ASS'Y PRESS-FITTING PART

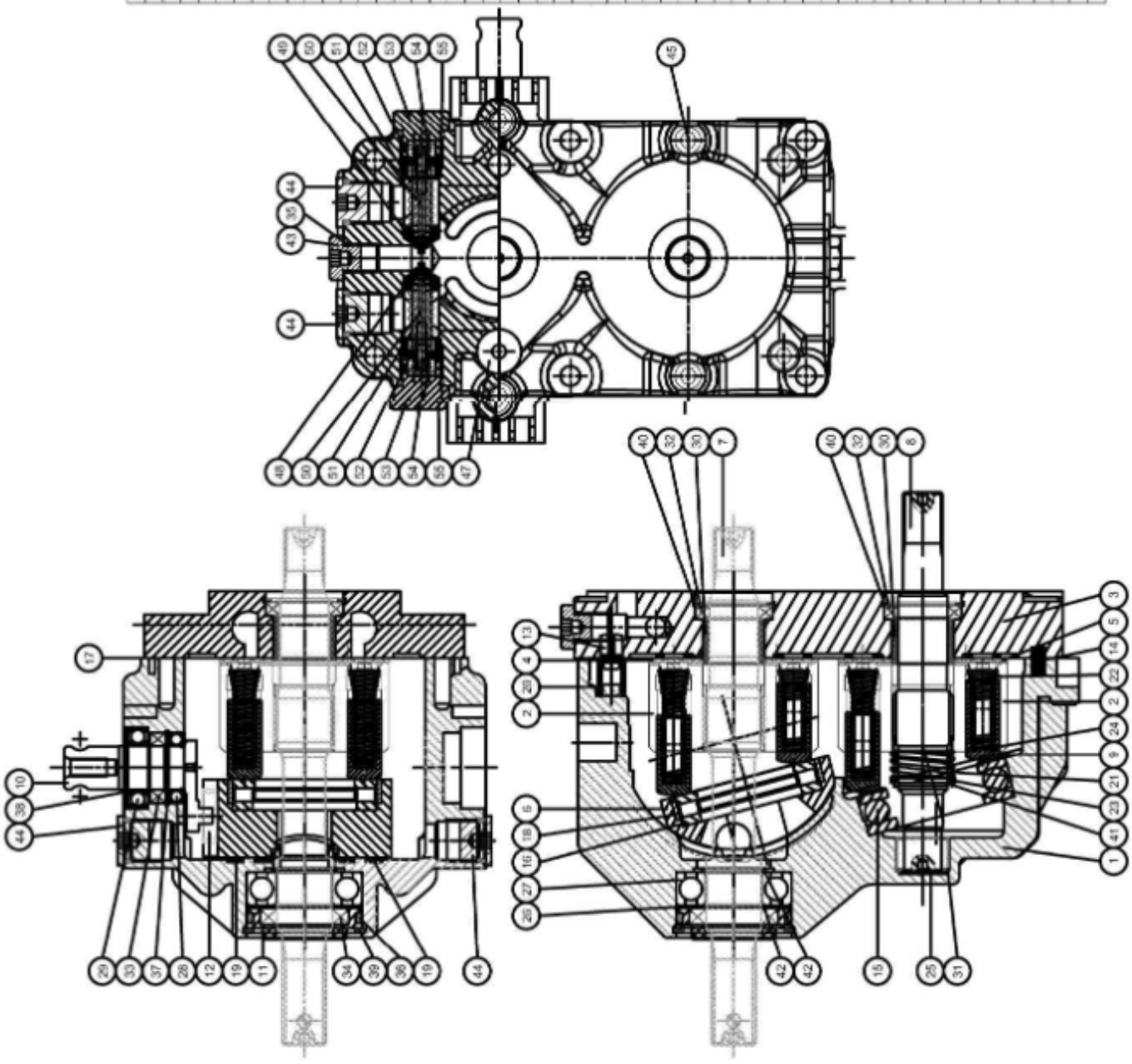


(Figure-36)SHAFT(P) ASS'Y PRESS-FITTING PART



(Figure-35) Assembly drawing

No.	Code	O-RING	Q'ty	Mat'l	Remarks
55	0X483	O-RING	2	SWP9	-
54	JAH021-1317	SPRING PIN	2	S45C	JAF34-16
53	JAH021-1316	HEX HEAD BOLT	2	S45C	JAF34-16
52	JAH021-1315	SWASHPLATE	2	S45C	-
51	JAH021-1314	SPRING PIN	2	SWPB	-
50	JAH021-1313	Screw	2	SCM415	-
49	JAH021-1312	HOUSE	1	SCM415	#17 ORIFICE HOLE
48	JAH021-1311	GASKET	1	SUM419	-
47	PW1008	RUBBER PLUG	2	-	#10mm
46	JAH021-1309	PIN	4	SUJ2	-
45	PW0940	BOLT	8	-	M6X60L
44	JAH021-1308	PLUG	6	S45C	JAF34-16
43	JAH021-1268	PLUG	1	S45C	JAF12-20
42	SR6025	SNAP RING	2	SK5	S25
41	SR5932	SNAP RING	1	SK5	S22
40	SR4185	SNAP RING	2	SK5	S85
39	SR1160	SNAP RING	1	SK5	S62
38	SR5930	SNAP RING	1	SK5	S29
37	SR4181	SNAP RING	1	SK5	S80
36	0X145	O-RING	1	NBR	P145
35	QA015	Q-RING	1	NBR	P2555-013
34	TDW04007	OIL SEAL	1	NBR	#75x95x10
33	TDW06007	OIL SEAL	1	NBR	#25x52x7/4
32	TDW05609	OIL SEAL	2	NBR	#17x35x8
31	PW17415	RETAINT BEARING	1	SUJ2	1BL1715
30	#45x68x20	NEEDLE BEARING	2	SUJ2	HK4520
29	#60x70x6	THRUST BEARING	1	SUJ2	6904
28	6900ZZ	BALL BEARING	1	SUJ2	6904
27	BB25x215	BALL BEARING	1	SUJ2	6205
26	JHT0-B-1040	PISTON ROD	1	S45C	-
25	JHT021-1280	PLATE	1	S45	#10x12
24	JHT060-1039	WASHER(PISTON)	18	S45	#10x12
23	JHT0-B-1210	SPRING(PISTON)	1	SWP5	#27.7x4x375
22	JHT0-B-1215	SPRING(PISTON)	18	SWP5	-
21	JHT0-B-1016	SPRING(CYL)	1	SWP5	-
20	JHT060-1063	SPRING (CHARGE)	1	SWP5	-
19	JHP021-1160	DRV BEARING	2	-	-
18	JHT0-B-1215	CYL BLOCK	1	SUJ2	#45x68x15
17	JHT0-B-1130	CASE	1	-	-
16	PSR455514	HEX SOCKET BOLT	1	SUJ2	#45x455x12T
15	1BR4581	HEX SOCKET BOLT	1	SUJ2	#45x455x12T
14	PP0012	PIN	2	SUJ2	#8x12L
13	JHT040-1040	SWITCH(SWASH)	1	SCM415	-
12	JHT060-1071	THROTTLE GUIDE	1	SCM440	-
11	JHT060-1138	GEAR COVER(F)	1	S45C	-
10	JHT0-B-1270	LEVER	1	SCM415	-
9	JHT060-1135	PISTON	18	SCM415	-
8	JHT0-B-1110	SHAFT(M)	1	SCM420	-
7	JHT0-B-1130	SHAFT(F)	1	SCM420	-
6	JHT0-B-1071	SWASH PLATE	1	SMF2020	-
5	JHT060-1038	VALVE PLATE(M)	1	S045+LB03	-
4	JHT0-B-1035	VALVE PLATE(F)	1	S045+LB03	-
3	JHT0-B-1045	VALVE CASING	1	FCD450	-
2	JHT060-1039	CYL BLOCK	2	SMF4030	-
1	JHT0-B-1015	MAIN CASING	1	ALDC12	-



(Figure-36) Section drawing

SECTION 1.GENERAL DESCRIPTION---------- 5-1
1.Wheel drive system---------- 5-1
2.PTO drive system---------- 5-1
3.Power train diagram---------- 5-1

SECTION 2. SPECIFICATIONS---------- 5-2
1. Wheel drive system---------- 5-2
2. PTO drive system---------- 5-2

SECTION 3. DISASSEMBLY, INSPECTION AND ----------
REASSEMBLY---------- 5-3

1. HST unit, range gears, 4WD gears and PTO clutch , rear PTO gears
Mid PTO gears ---------- 5-3
2. Transmission assembly ---------- 5-17

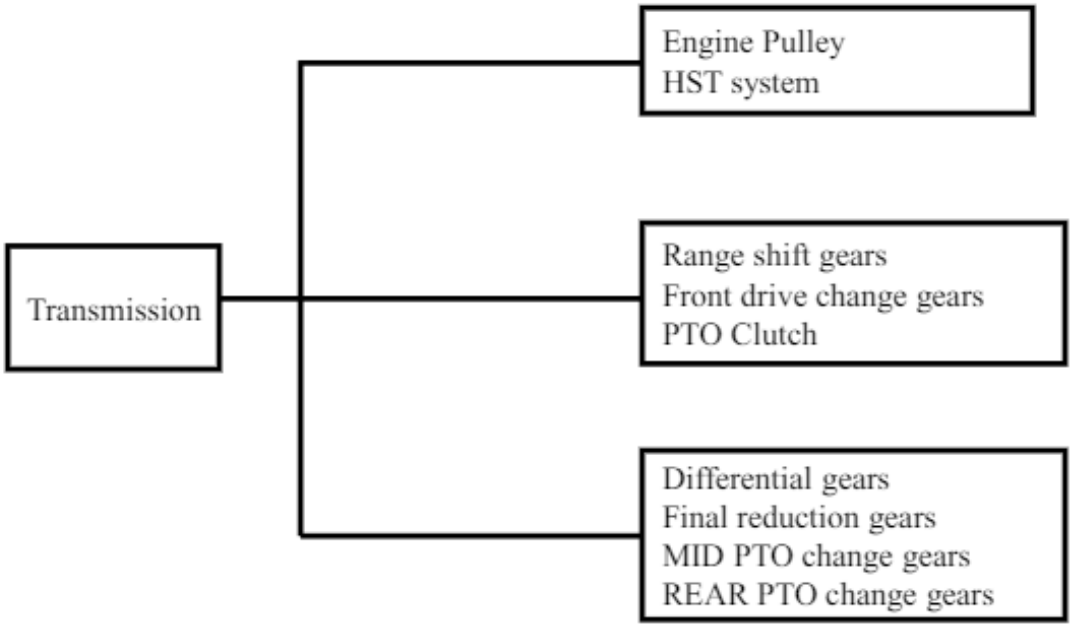
SECTION 4.TROUBLE SHOOTING---------- 5-19
1. Wheel drive system---------- 5-19
2. PTO drive system---------- 5-20

Chapter 5 .Transmission

SECTION 1. GENERAL DESCRIPTION

1. WHEEL DRIVING SYSTEM

The wheel driving system is composed of the following major components:



Wheel drive system

2. PTO DRIVE SYSTEM

(1) PTO drive system is composed of the hydraulic clutch and the PTO change gears.
(2) PTO drive system is composed of MID PTO and REAR PTO, which is referred POWER TRAIN DIAGRAMS.

3. POWER TRAIN DIAGRAM

Refer to page 5-3 at the end of this chapter.

SECTION 2. SPECIFICATIONS

1. WHEEL DRIVE SYSTEM

Unit : km/h

eMax S20 HST			
Speed shift range		Engine rated rpm : 3000 rpm	
Reduction ratio	Main speed shift	HST	
	Speed range shift	L (Low) H (High)	0.517 (15/29) 1.095 (23/21)
	Drive pinion-Wheel gear		0.485 (16/33)
Operation methods	Speed range shift		Side shift – L / H
Oil capacity	Transmission case	Recommended Oil	THF 500 (API GL-4 Grades) Gear oil SAE80W -90
		Capacity	14 ℓ

2. PTO DRIVE SYSTEM

MODEL		eMax S20 HST
TYPE		INDEPENDANT
CLUTCH		Multiple Wet Disk
Rear PTO	Speed shift range	1
	Reduction ratio	0.184 (22/41*13/38)
	PTO shaft speed	540 @ Engine 2,942rpm
	PTO shaft size	Φ35 mm, 6 straight splines
	Rotation direction	CW viewed from the rear
Mid PTO	Speed shift range	1
	Reduction ratio	0.845 (22/41*35/25*27/24)
	PTO shaft speed	2500 @ Engine 2,958 rpm
	PTO shaft size	15 straight splines (DP16/32)
	Rotation direction	CW viewed from the front side
PTO clutch	Type	Wet, multi-disc, hydraulic-operated clutch
	Number of clutch plates	Friction 5, Plate 5
	Used oil	THF500(GEAR OIL SAE 80W-90)

SECTION 3. DISASSEMBLY, INSPECTION AND REASSEMBLY

1. HST unit, range gears, 4WD gears and PTO clutch, Rear PTO gears, Mid PTO gears.

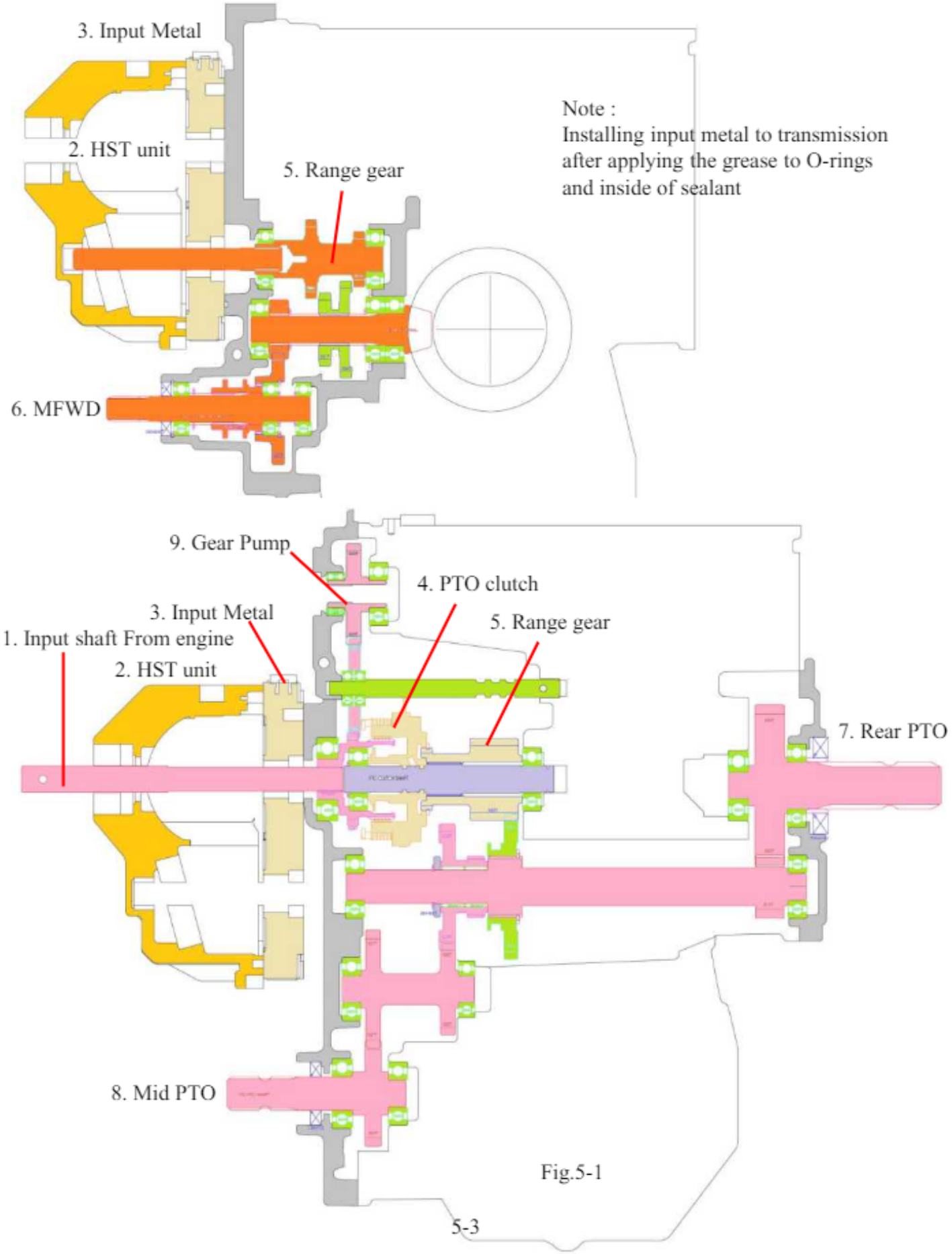
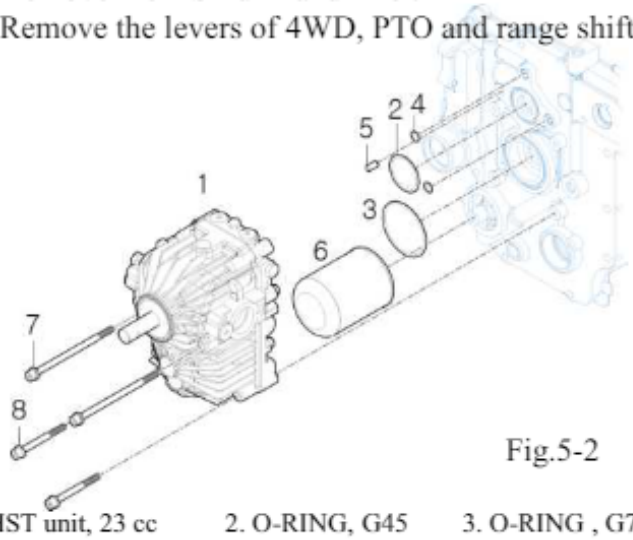


Fig.5-1

1.1 Disassembly.

Removal of **HST system** and change parts.
Separate the engine from the rear transmission referring to the paragraph of SECTION 8. REPAIR in CHAPTER 4.

1) Remove the HST unit and filter.
Remove the levers of 4WD, PTO and range shifting.



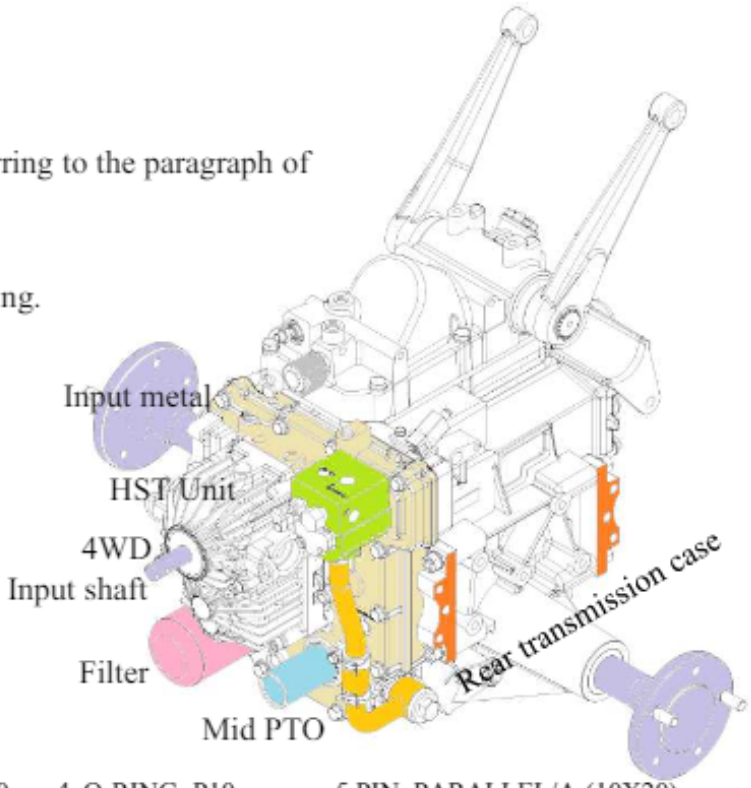
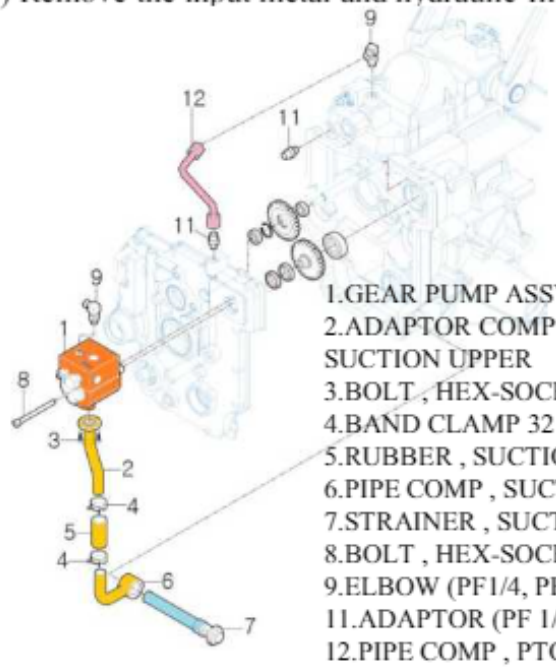


Fig.5-2

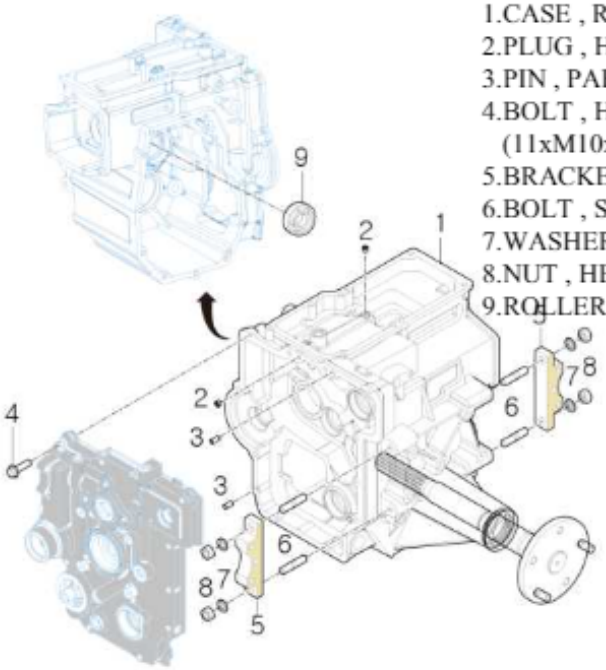
1. HST unit, 23 cc 2. O-RING, G45 3. O-RING , G70 4. O-RING, P10 5 PIN, PARALLEL/A (10X20)
6. FILTER COMP , HST 7. BOLT , HEX SOCKET (M8X140) 8. BOLT , HEX SOCKET (M8X75)

Note : Disassembly of the HST unit assembly should be done in a clean, dust-free place.
Pay special attention to avoid damage of the filter and O-rings etc.

2) Remove the input metal and hydraulic filter.



1.GEAR PUMP ASSY
2.ADAPTOR COMP , SUCTION UPPER
3.BOLT , HEX-SOCKET
4.BAND CLAMP 32
5.RUBBER , SUCTION
6.PIPE COMP , SUCTION
7.STRAINER , SUCTION
8.BOLT , HEX-SOCKET
9.ELBOW (PF1/4, PF1/4)
11.ADAPTOR (PF 1/4)
12.PIPE COMP , PTO



1.CASE , REAR TM
2.PLUG , HEX-SOCKET
3.PIN , PARALLEL/A
4.BOLT , HEX FLANGE (11xM10x1.5P-35)
5.BRACKET , MTG
6.BOLT , STUD/2
7.WASHER , SPRING
8.NUT , HEX/2
9.ROLLER BEARING

Fig.5-3 Input metal

Note : Disassembly of the hydraulic filter and gear pump should be done in a clean, dust-free place.
And slightly separate the input metal from rear transmission not to damage the gears in TM.
Pay special attention to avoid damage of the PTO solenoid valve.

N.B : 4WD and Mid PTO shaft should be clean to protect the oil seal before the input metal is removed.

3) Remove the 4WD shift arm, range shift arm and PTO shift linkage.

Remove the hydraulic cylinder assembly.

Separate the input metal from rear TM gradually. Be careful not to damage all parts.

Remove the gear pump gears, drive gears, 4WD gears and PTO gears and mid PTO gears.

Remove the PTO cover and gears.

Note : The 4WD shaft and Mid PTO shaft should be clean ahead of time to protect the sealant.

Pay attention not to drop some parts to the ground.

Specially disassembly of the PTO clutch assembly should be done in a clean, dust-free place.

Oil may drain from the rear TM. Have a suitable container ready to catch the excess oil.

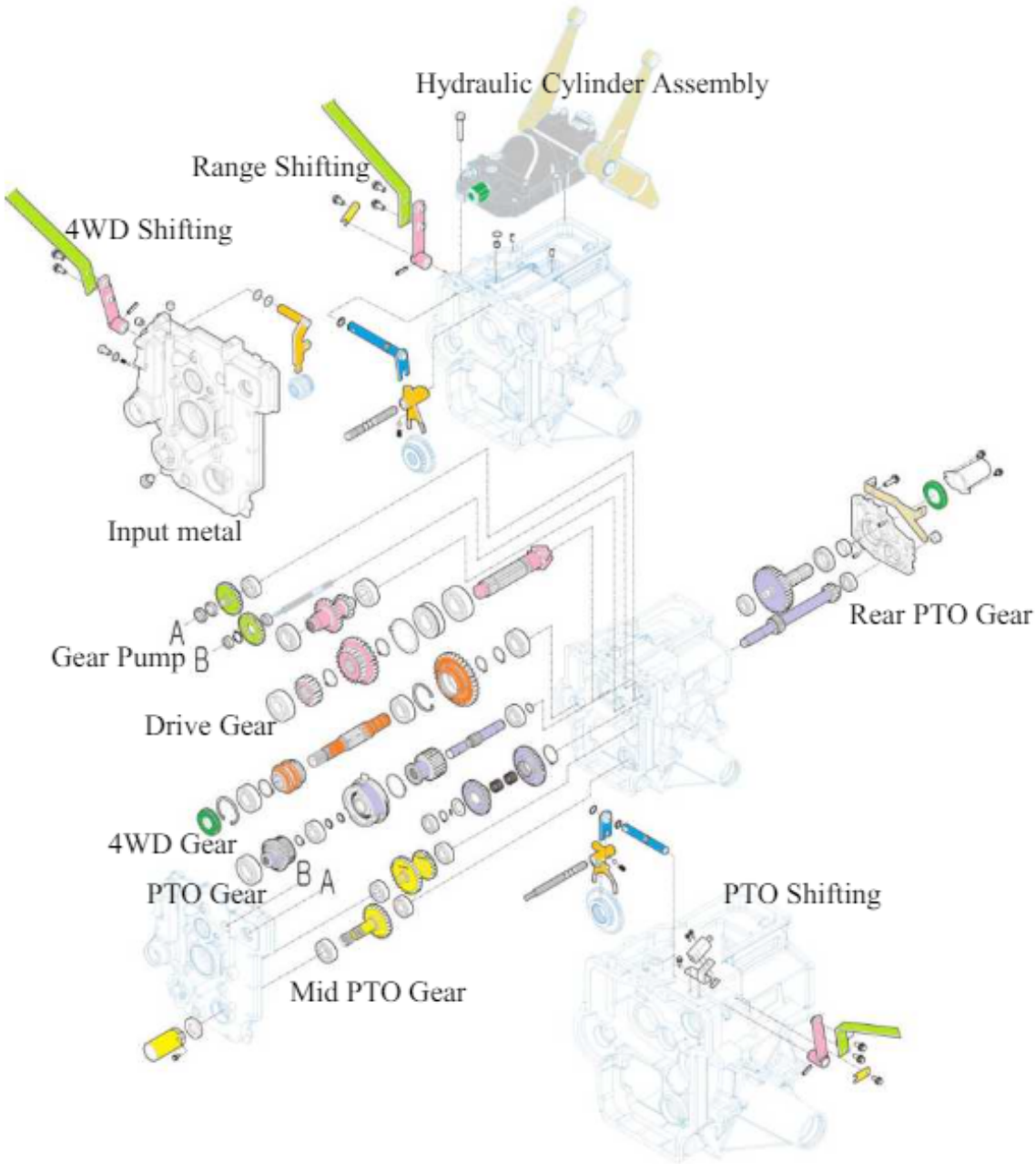


Fig.5-4

4) Remove the bolts which are tightened to rear axle housing (10x M10x1.5p-35).

Remove the diff-lock arm and diff-lock linkage.

Separate the rear axle housing from the rear TM gradually.

Take out the pinion shaft, spiral bevel gear, stopper ring and brake system.

Note : All of parts should be done in a clean, dust-free place.

Be careful not to drop some parts to the ground. Specially pay attention to protect the brake system.

Remove the differential gear and the diff-lock stay and fork.

Remove the ring gear.

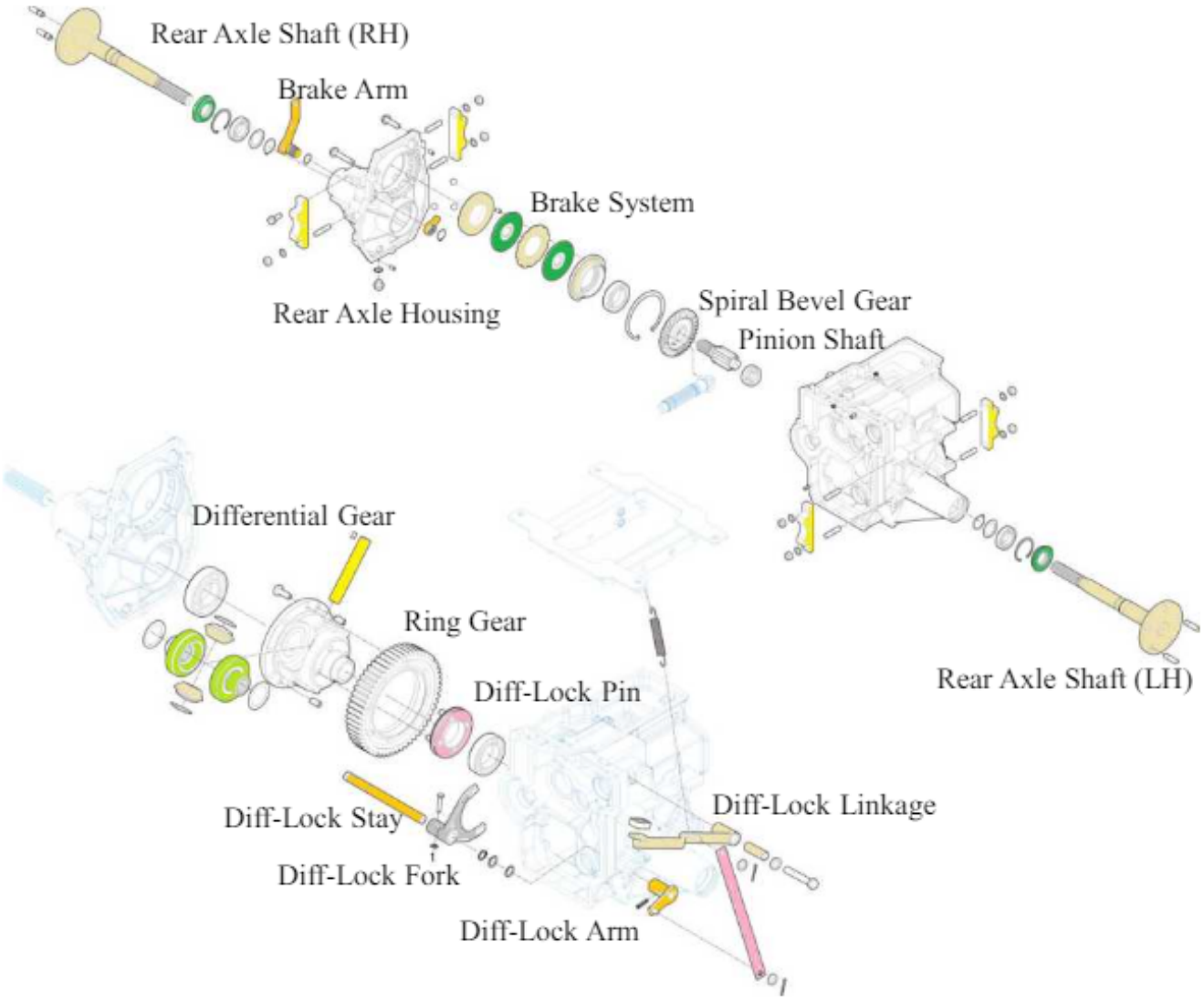


Fig.5-5

5) Disassembly, inspection and reassembly of the PTO clutch assembly

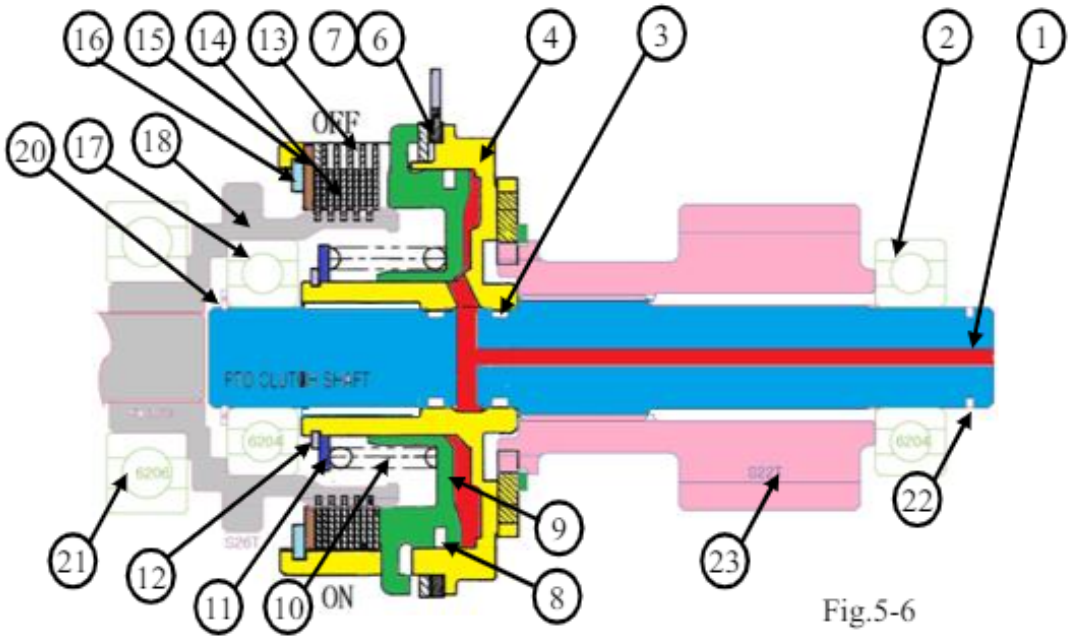


Fig.5-6

1.SHAFT, PTO CLUTCH 2.BEARING BALL (6204) 3.O-RING (P16) 4.CASE 6.PLATE, BRAKE
7.DISK, BRAKE 8.D-RING 9.PISTON 10.SPRING 11.COLLAR
12.C-RING, SHAFT (32) 13.PLATE, SEPARATE 14.CLUTCH DISK 15.BACK PLATE 16. C-RING, HOLE (80)
17. BEARING, BALL (6204) 18. HUB , PTO CLUTCH 20.C-RING, SHAFT (20) 21.BEARING, BALL(6206)
22.SEAL (20) 23.GEAR SPUR 22T

Note : Disassembly of the PTO clutch assembly should be done in a clean, dust-free place.
Pay special attention to avoid damage of the seal rings etc.

5.1) Removal

a. Remove the seal(no. 22) and bearing (no. 21) and PTO clutch hub(no. 18).
b. Pull out C-ring (no. 20) and bearing(no. 17).
c. Pull out PTO clutch shaft towards right side. Be careful not to damage O-rings.
d. Remove C-Ring (no. 16) and back plate and clutch disc and separate assembly.
e. While holding return spring compressed with a special tool, remove C-Ring(no. 12) as shown in below picture.
f. Disassemble collar, spring, piston and O-Ring, and no. 6, 7.

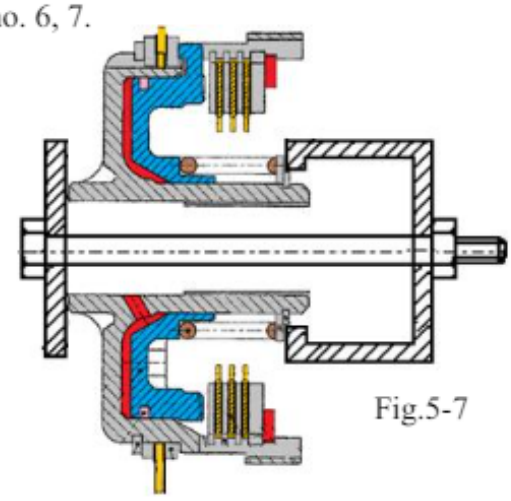


Fig.5-7

5.2) INSPECTION

a. Case assembly
-Replace a case assembly which has a damaged or worn sliding surface.
-If there is any damage to the case assembly and the piston seal ring, these parts should also be replaced.
b. Disk assembly
- If the disk and separate plate are worn or bunt, replace both the disk assembly and plate.
c. If there is particular damage in case assembly, PTO clutch assembly should be replaced.

Note : When pulling out the C-Ring,
be careful not to make serious situation.
The spring can jump out of the case.

5.3) Reassembly

a. Reassemble the parts in reverse order of removal.

b. Each parts should be washed by clean oil before reassembly.

c. Apply multi-purpose grease or fresh oil to O-ring. When installed, be careful not to damage them.

d. Every time a gear and bearing are installed, its smooth rotation should be checked.

e. Every snap ring should be seated securely in its groove.

f. When the C-ring (no. 12) is installed, special care has been taken to avoid the serious situation for the spring. It can jump out of the case. The special tool should be used as shown in below.

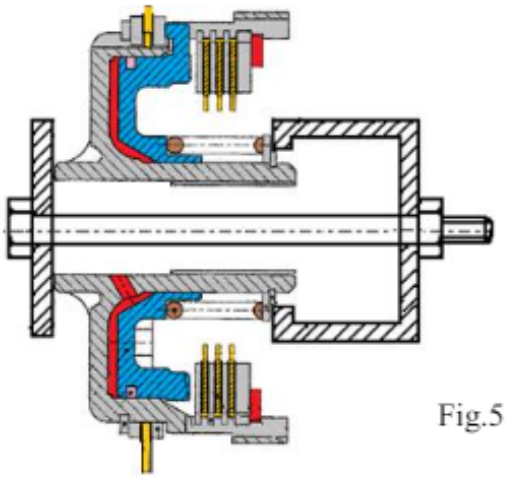


Fig.5-8

g. When pushing respective bearings into the shaft or hole, be careful only to push their inner or outer races.

h. Install the snap ring in correct direction.

i. After reassembly, check to see that the hub turns smoothly by locking the PTO clutch.

j. When the PTO clutch assembly is installed in transmission case, make sure that the turning lock of PTO clutch is securely seated in transmission case as shown in below picture.

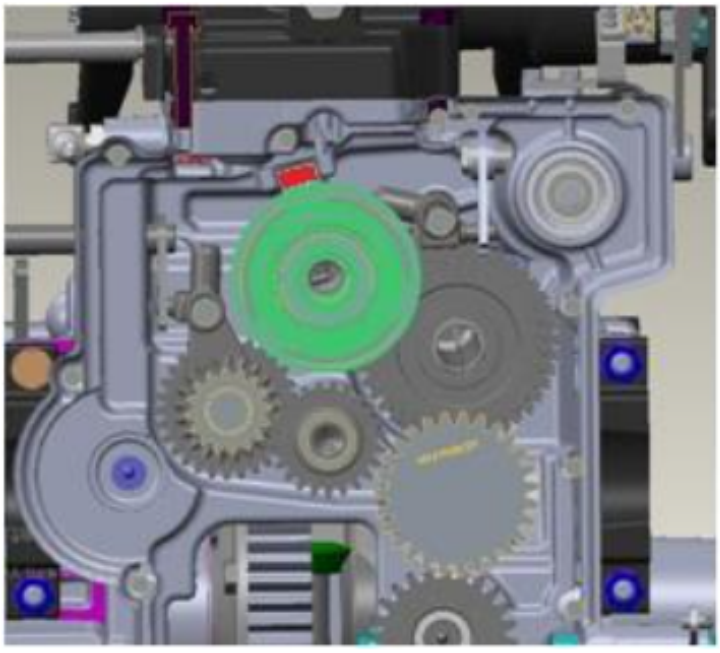


Fig.5-9

1.2 Reassembly and inspection

Reassemble the parts in the reverse order of disassembly.

Note : When installed, all parts should be washed with clean oil ahead of time.

1) Put the rear transmission case to safety area.
   Install the shaft (12) into the rear transmission case.
   Install the PTO counter gears in order to number to the shaft (12).
   Install the PTO shifting.

Note : Be sure the stopper ring should be seated to the groove security.
   And install in the correct direction should be careful.

2) Install the bearings(3, 4) to rear PTO shaft(2).
   Install the sleeve to the rear PTO shaft after applying the grease all surface of the sleeve(5).
   Install the rear PTO shaft and the bearings together to PTO cover.
   Install the sealant (6) to PTO cover.
   Assemble the bracket and cap

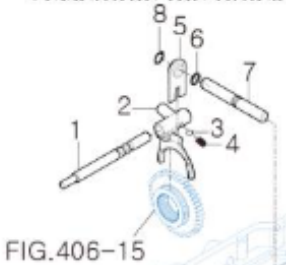
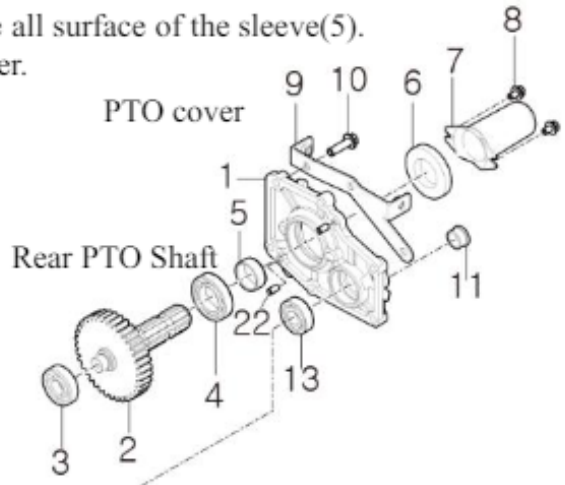


FIG.406-15

PTO shifting

1.STAY , PTO SHIFT 2.FORK , PTO
3.BALL , STEEL 4.PIN , SPRING
5.HOOK COMP, PTO 6.O-RING , P
7.SHAFT , PTO SHIFT 8.C-RING , SHAFT
9.ARM COMP , PTO 10.PIN , SPRING
11.PLATE 12.BOLT , HEX/S



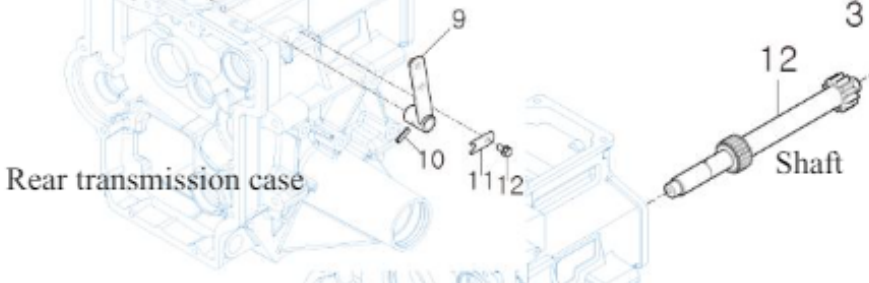
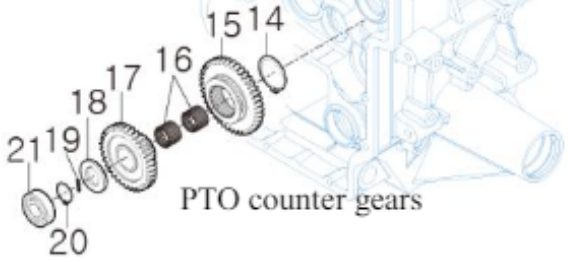


Fig.5-10



1.COVER , PTO 2.GEAR , SPUR 38T
3.BEARING , BALL 4.BEARING , BALL 5.SLEEVE
6.SEAL ASSY , OIL 7.CAP , PTO SHAFT 8.BOLT , HEX/SP
9.BRACKET COMP, PTO SHIELD 10.BOLT , HEX FLANGE
11.GAUGE ASSY , OIL LEVEL 12.SHAFT , PTO COUNT 13T
13.BEARING , BALL 14.C-RING , SHAFT 15.GEAR , SPUR 41T
16.NEEDLE BEARING(CAGE) 17.GEAR , SPUR 35T
18.WASHER , 25X45X5 19.PIN , SPRING 20.C-RING , SHAFT
21.BEARING , BALL 22.PIN , PARALLEL/A

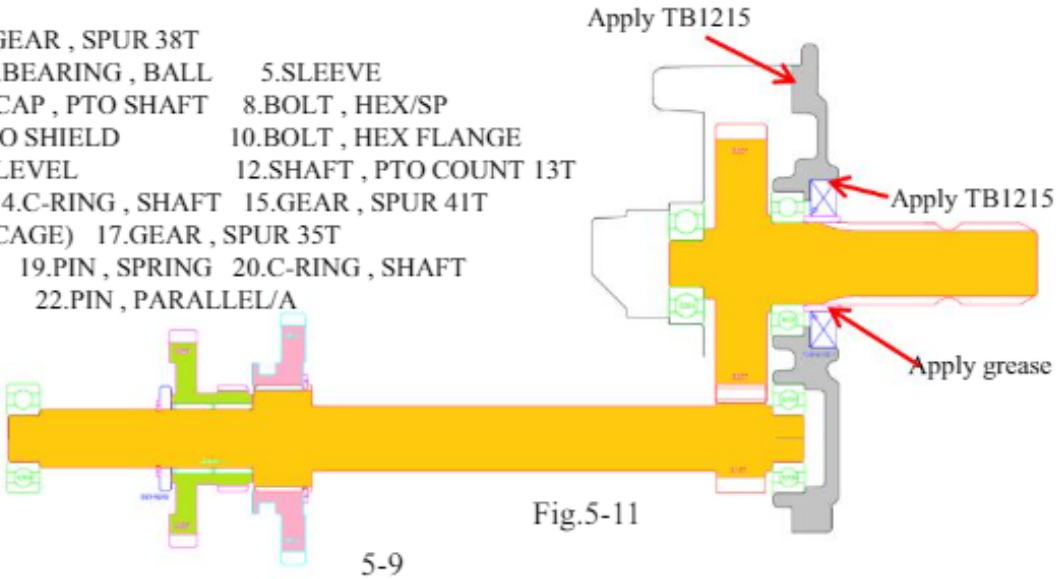
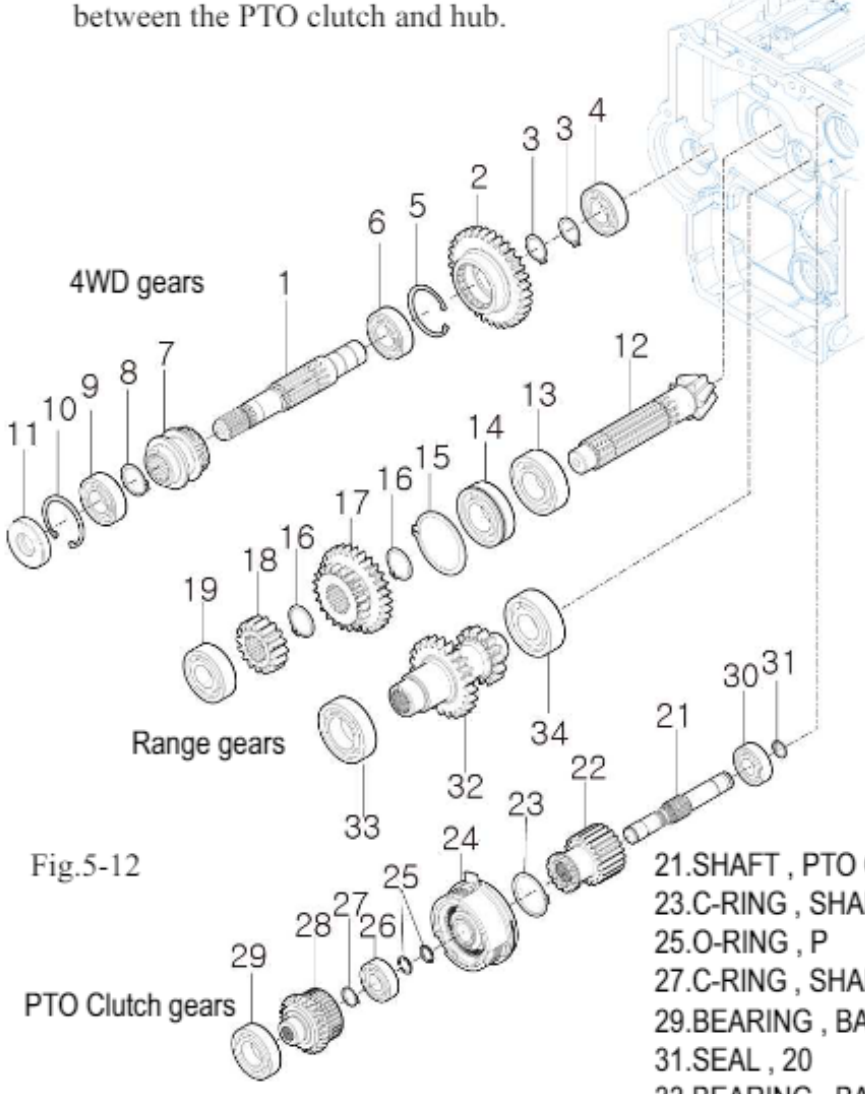


Fig.5-11

3) Install the bearings(13, 14) and stopper ring(15) to the spiral bevel pinion (12).
Install the spiral bevel pinion to the rear transmission case.
Install the range gears and PTO clutch gears and 4WD gears together.
Install the range shifting lever.

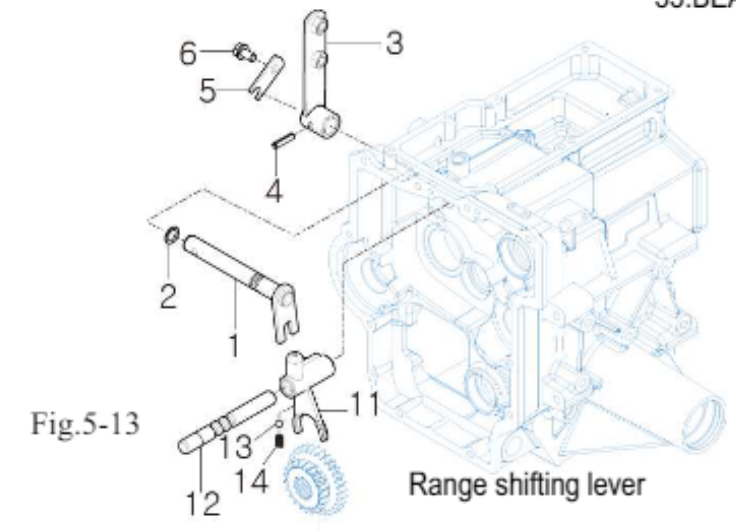
Note : Specially be sure the PTO clutch hub(28) should be set up to PTO clutch assembly to be aligned between the PTO clutch and hub.



1.SHAFT , 4WD
2.GEAR , SPUR 33T
3.C-RING , SHAFT
4.BEARING , BALL
5.C-RING , HOLE
6.BEARING , BALL
7.SLEEVE , 4WD
8.C-RING , SHAFT
9.BEARING , BALL
10.C-RING , HOLE
11.SEAL , OIL/D
12.PINION , SPIRAL BEVEL 7T
13.BEARING , BALL/HL1
14.BEARING , BALL/HL/1/N
15.C-RING , SHAFT
16.C-RING , SHAFT
17.GEAR , SPUR 21T-29T
18.GEAR , SPUR 16T
19.BEARING , BALL/HL1

Fig.5-12

21.SHAFT , PTO CLUTCH
22.GEAR , SPUR 22T
23.C-RING , SHAFT
24.CLUTCH ASSY , PTO
25.O-RING , P
26.BEARING , BALL
27.C-RING , SHAFT
28.HUB , PTO CLUTCH 26T
29.BEARING , BALL
30.BEARING , BALL
31.SEAL , 20
32.GEAR , SPUR 15T-23T
33.BEARING , BALL
34.BEARING , BALL



1.HOOK COMP , RANGE
2.O-RING , P
3.ARM COMP , RANGE
4.PIN , SPRING
5.PLATE
6.BOLT , HEX/S
11.FORK , RANGE
12.STAY , RANGE SHIFT
13.BALL , STEEL
14.SPRING(HC023)

Fig.5-13

FIG.404-17

Note : Be careful not to lose the steel bal.
It can jump out of the spring.

Note : When the shifting stay is installed into the shifting fork, Install the spring and ball and stay to the fork as shown in the picture. And after applying the grease on the O-ring.

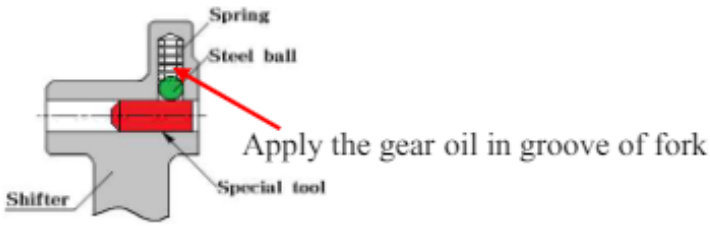


Fig.5-14

Note : Install the spring pin as shown in the picture.

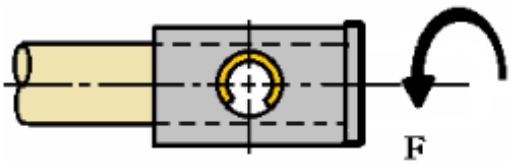


Fig.5-15

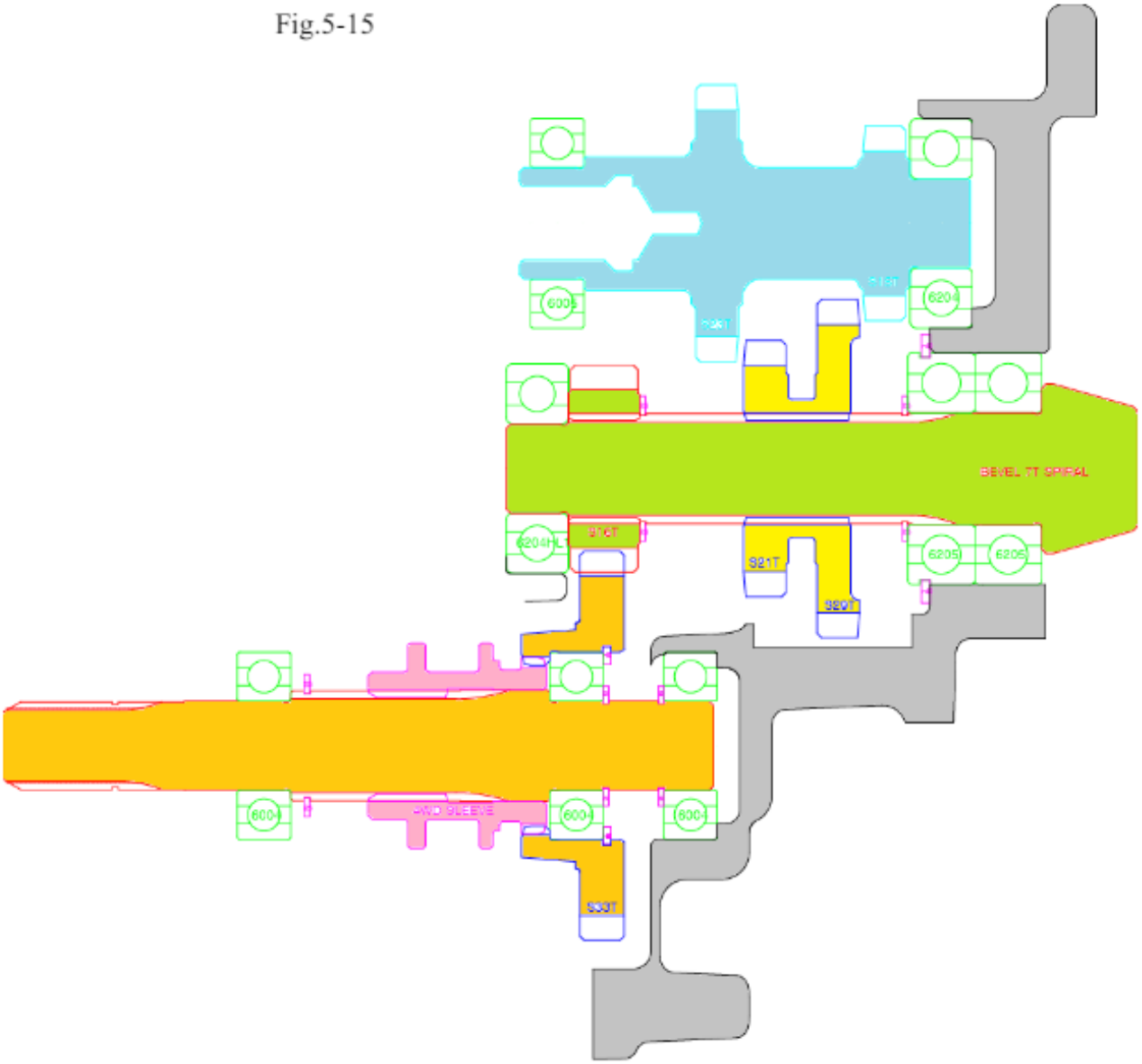


Fig.5-16 Range gears

4) Install the gears for gear pump.

13.GEAR , SPUR 28T
14.BALL BEARING
15.BEARING , BALL 62.4
16.GEAR , SPUR 28T
17.C-RING , HOLE 26
18.BEARING , BALL 6000
19.BEARING , BALL 6000

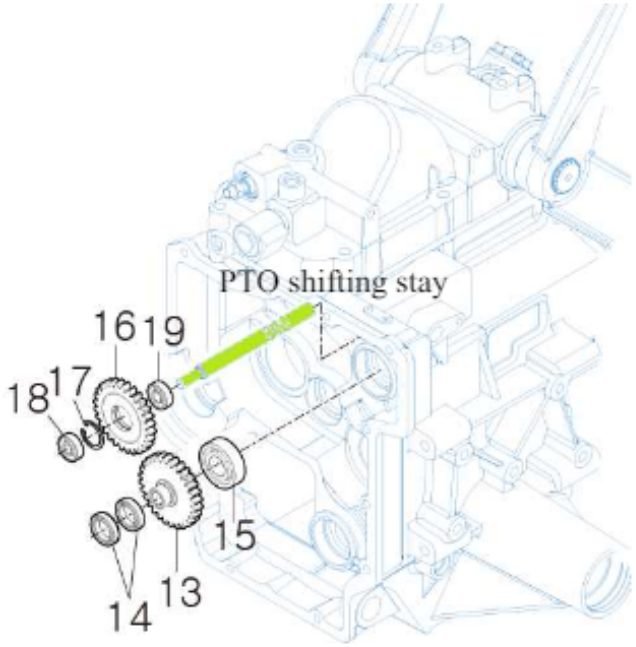


Fig.5-17

5) Install the mid PTO gears.
Install the sealant (7) and cap (8), when the input metal is reassembled .

1.GEAR , SPUR 25T-27T
2.BEARING , BALL
3.BEARING , BALL
4.SHAFT , MID PTO
5.BEARING , BALL
6.BEARING , BALL
7.SEAL , OIL/D
8.CAP COMP , MID PTO SHAFT
8.BOLT , HEX /S

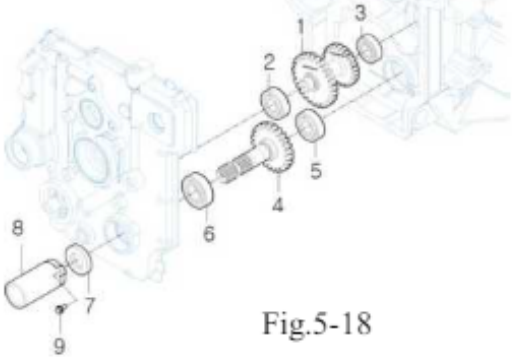


Fig.5-18

6) Install the rear axle shaft (LH) to the rear transmission case.
Install the sealant(11), stopper ring(12), bearing(13), washer(14), stopper ring (15) and to the rear axle shaft(10).

Note: Apply the adhesive(TB1215) on the outside of sealant (11).
Apply the grease on the rib inside sealant(11).
Install the shaft(10) with related parts.
Install the sealant(11) into the rear transmission case.

Tightening torque (#6 Stud Bolt)	
M12x1.75	6 ~ 6.5 Kgf.m (43 ~ 47lb.fts)

1.CASE , REAR TM
2.PLUG , HEX-SOCKET
3.PIN , PARALLEL/A
4.BOLT , HEX FLANGE
5. BRACKET , MTG
6.BOLT , STUD/M12-40
7.WASHER , SPRING
8.NUT , HEX/2
9.ROLLER BEARING
10.SHAFT, RR WHEEL
11.SEAL , SHAFT 40
12.C-RING , HOLE
13.BEARING , BALL
14.WASHER , 35X50X02
15.C-RING , SHAFT
16.WHEEL , STUD

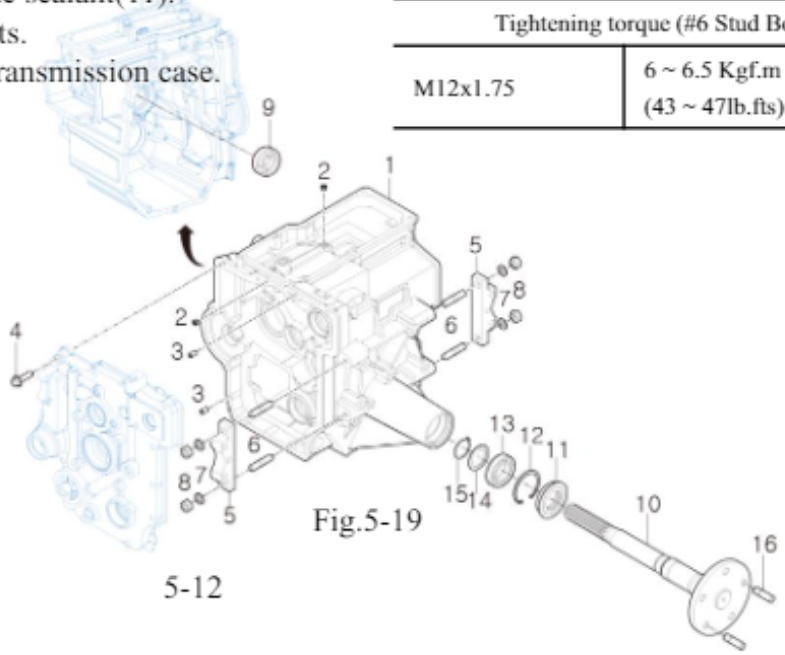
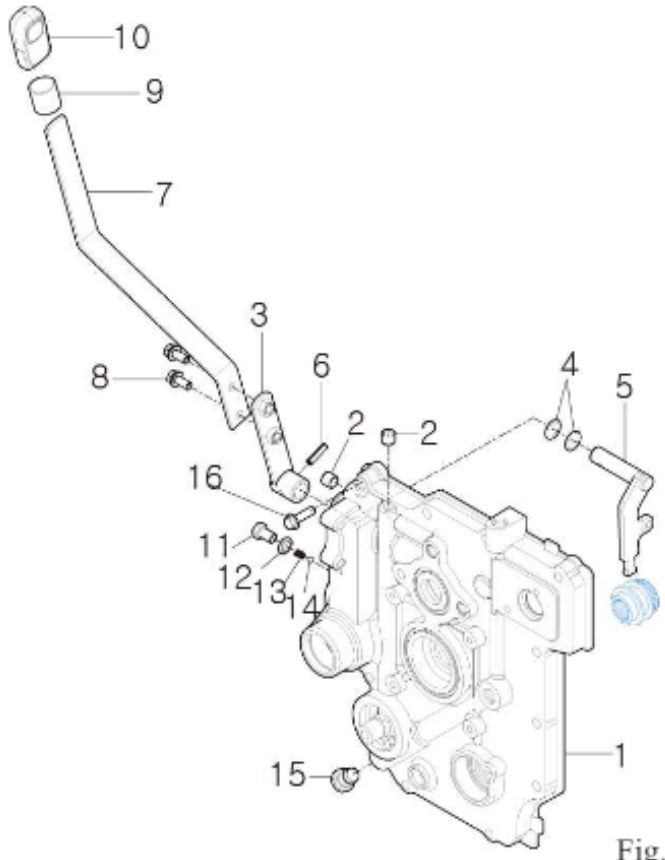


Fig.5-19

7) Install O-rings to 4WD arm comp. Apply the grease on the O-rings.
Install the 4WD arm comp(5) into the range arm comp through the input metal.

Note : Apply the adhesive (TB1215) on the rear transmission case.
Make sure that the 4WD arm comp should be seated in the groove of sleeve.
Install the ball, spring, washer and bolt to the specified torque.
Install the other parts as shown in the below picture.

Tightening torque (#16 Bolt)	
M10x1.5P-35L	3.3 ~ 4.5 Kgf.m (23.8 ~ 32.5lb.fts)



1.METAL , INPUT
2.PLUG , HEX-SOCKET
3.ARM COMP , RANGE
4.O-RING , P
5.ARM COMP, 4WD
6.PIN , SPRING 6x25
7.LEVER , 4WD
8.BOLT , HEX/SP M8x20
9.TUBE
10.KNOB , 4WD
11.BOLT , HEX
12.WASHER , SEAL
13.SPRING , HC017
14.BALL , STEEL
15.PLUG
16.Bolt M10x35

Fig.5-20

Note : Be careful not to lose the steel bal.
It can jump out of the spring.

8) Apply a coat of molybdenum of molybdenum disulfide-based grease(Three bond TB1901 or equivalent) to revolving or sliding parts prior to reassembly.

Assemble the bevel gears and washers and pinion gears into the differential case.

Install the pin(7) and key(8).

Install the pins(10) and spur gear 56T and sleeve comp (12) and bearings to the differential case.

Install the O-ring and C-rings and fork to the diff lock shaft.

Install the pin(19) into the holes of both the shaft and fork.

Assemble the washer(20) and pin(21) to pin(19).

All parts above is installed to the rear transmission case at same time.

Assemble the arm comp and pin(30) to the shaft.

Other parts are installed as shown in the below picture.

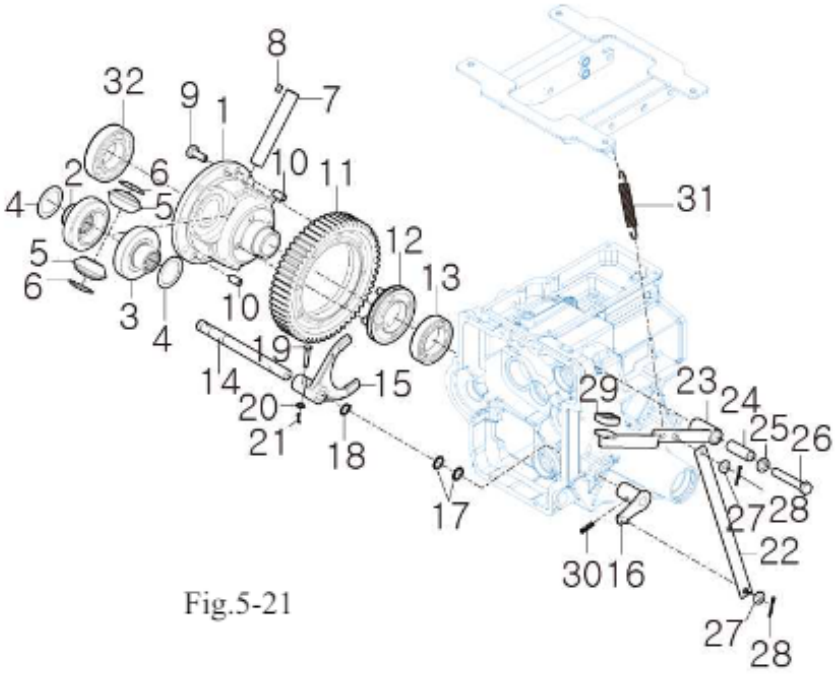


Fig.5-21

1.CASE , DIFF 2.GEAR , BEVEL 20T 3.GEAR , BEVEL 20T
4.THRUST WASHER , 38X52X01 5.PINION , DIFF 12T 6.WASHER , DIFF PINION
7.SHAFT , DIFF PINION 8.KEY 9.BOLT , HEX/S 10.PIN , PARALLEL/A
11.GEAR , SPUR 56T 12.SLEEVE COMP , DIFF LOCK 13.BEARING , BALL
14.SHAFT , DIFF LOCK 15.FORK , DIFF LOCK 16.ARM COMP , DIFF LOCK
17.O-RING , P 18.C-RING , SHAFT 19.PIN (6X32) 20.WASHER , PLAIN
21.PIN , SPLIT 22.LINK , DIFF 23.PEDAL COMP , DIFFLOCK 24.BUSH
25.WASHER , SPRING 26.BOLT , HEX 27.WASHER , PLAIN 28.PIN D2.5x20
29.PAD 30.PIN , SPRING 31.RETURN SPRING , CLUTCH 32.BEARING , BALL

Note : Be careful not to lose the steel bal.
It can jump out of the spring.

9) Install the rear axle housing (RH) to the rear transmission case.
Install the sealant(27), stopper ring(28), bearing(29), washer(30), stopper ring (31) and to the rear axle shaft(26).

Note: Apply the adhesive(TB1215) on the outside of sealant (27).
Apply the grease on the rib inside sealant(27) and the rear axle shaft sufficiently to protect the sealant.

Install the shaft(26) with related parts to the rear axle housing(1).
Install the stopper ring(28) into the groove of rear axle housing(1).
Install the sealant(27) into the rear axle housing(1).

10) Install the brake cam(21) and arm comp(19) and O-ring and stopper ring.
Install the balls(11), pressure plate(10), pin(9), disk, separate, disk, metal(5), stopper ring(4), bearing(6), spiral bevel gear(3) and spur gear(2).
Install the related parts.
Install the rear axle housing assembly to the rear transmission case after applying the adhesive(TB1215).

Tightening torque (#15 Stud Bolt)	
M12x1.75-30L	6 ~ 6.5 Kgf.m (43 ~ 47lb.fts)

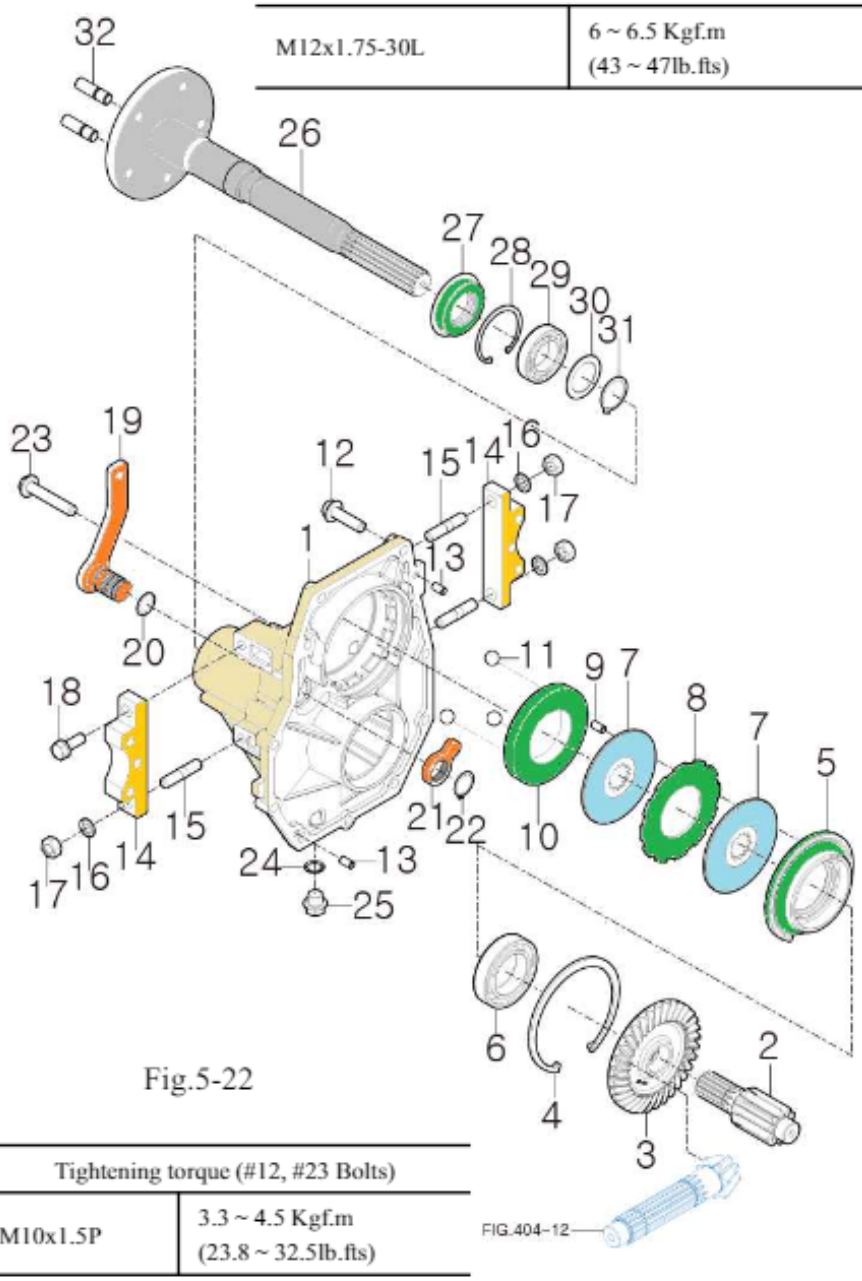


Fig.5-22

Tightening torque (#12, #23 Bolts)	
M10x1.5P	3.3 ~ 4.5 Kgf.m (23.8 ~ 32.5lb.fts)

1.AXLE HOUSING , RR
2.GEAR , SPUR 10T
3.GEAR , SPIRAL BEVEL 33T
4.C-RING , HOLE
5.METAL , BRAKE
6.BEARING , BALL 6208
7.DISK , BRAKE
8.PLATE , SEPARATE
9.PIN , PARALLEL/A 8x16
10.PLATE , PRESSURE
11.STEEL , BALL
12.BOLT , HEX FLANGE M10x35
13.PIN , PARALLEL/A 8x16
14.BRACKET , MTG
15.BOLT , STUD/ M12x30
16.WASHER , SPRING M12
17.NUT , HEX/ M12
18.BOLT , HEX/ M12x30
19.ARM COMP, BRAKE
20.O-RING , P
21.CAM , BRAKE
22.C-RING , SHAFT 25
23.BOLT , HEX FLANGE M10x50
24.O-RING , P
25.PLUG , DRAIN (MAGNET)
26.SHAFT, RR WHEEL
27.SEAL , SHAFT 40
28.C-RING , HOLE 62
29.BEARING , BALL 6007
30.WASHER , 35X50X02
31.C-RING , SHAFT 35
32.WHEEL , STUD

11) Rear PTO and MID PTO OPERATION

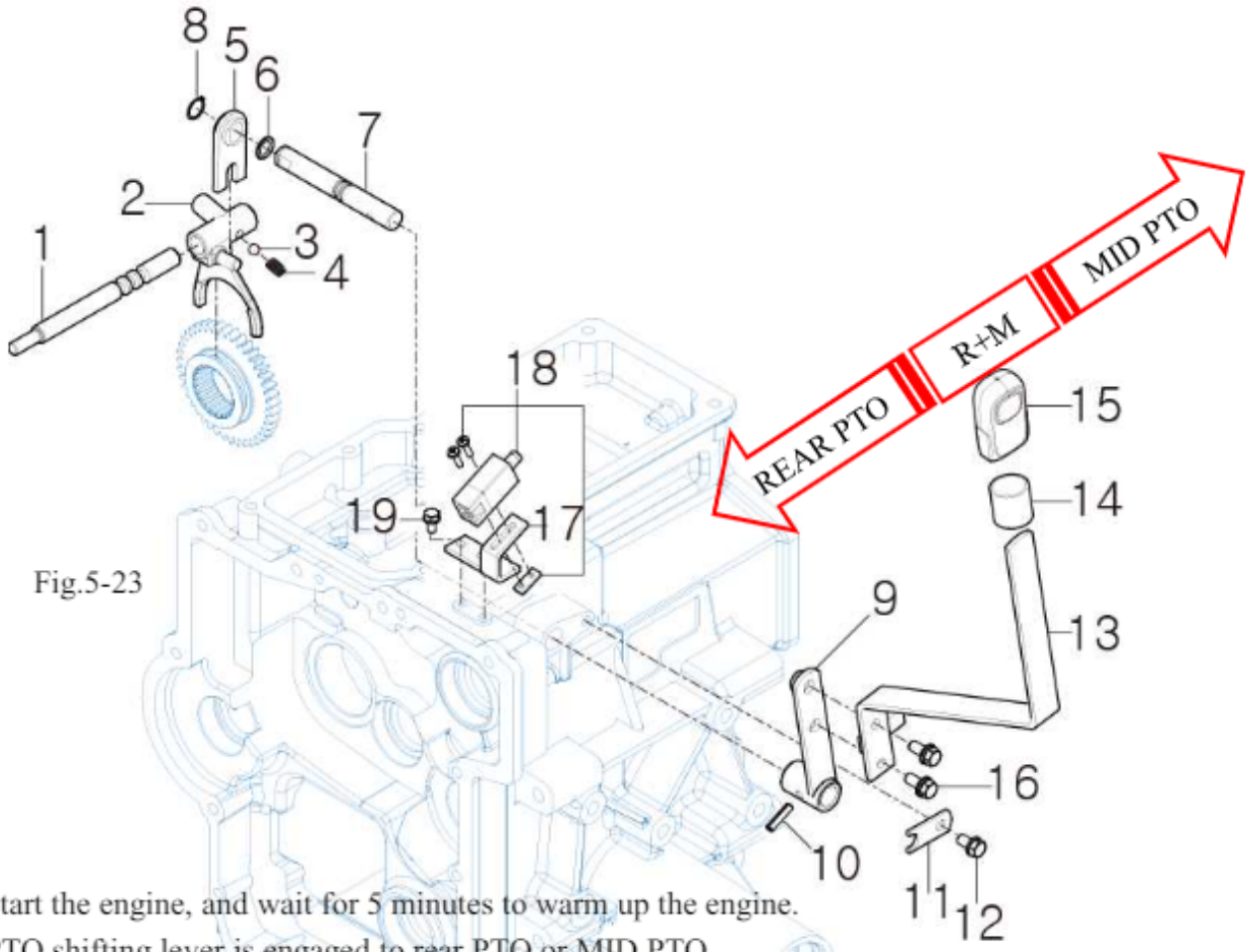


Fig.5-23

a. Start the engine, and wait for 5 minutes to warm up the engine.
PTO shifting lever is engaged to rear PTO or MID PTO.
PTO switch is ON while engine works, the hydraulic fluid of PTO Valve flows to PTO clutch through hydraulic line.

b. The fluid flows to actuator and piston operates to protrude.

c. If MID PTO gear is engaged and PTO switch is ON, it is normal operation.
If MID PTO is stopped, PTO switch must be OFF position or the safety switch in seat is released.

d. The PTO switch must be OFF position before PTO is engaged.
The speed of MID PTO is 2,500 rpm. Use the PTO lever to engage.
Decrease engine speed to near idle.
Make sure that PTO switch is OFF
If operator turns off PTO switch, Rear PTO and Mid PTO are off at once.

⚠ CAUTION

Do not operate any implement at a high speed than is specified for it. When making adjustments to the implement, stop the Engine to avoid serious injury.

When leaving the tractor, stop the Engine and remove the Key .Set the parking brake

1.3) Inspection

Before and after disassembly, inspect each part for serious worn or damaged part, and replace if necessary. Inspect bearings such as ball bearings and needle bearings for abnormalities in rotation such as irregularity, hitching by turning them with pressure applied by hand.
Replace defective ones.

2. Transmission assembly.

1)PTO system and gear pump

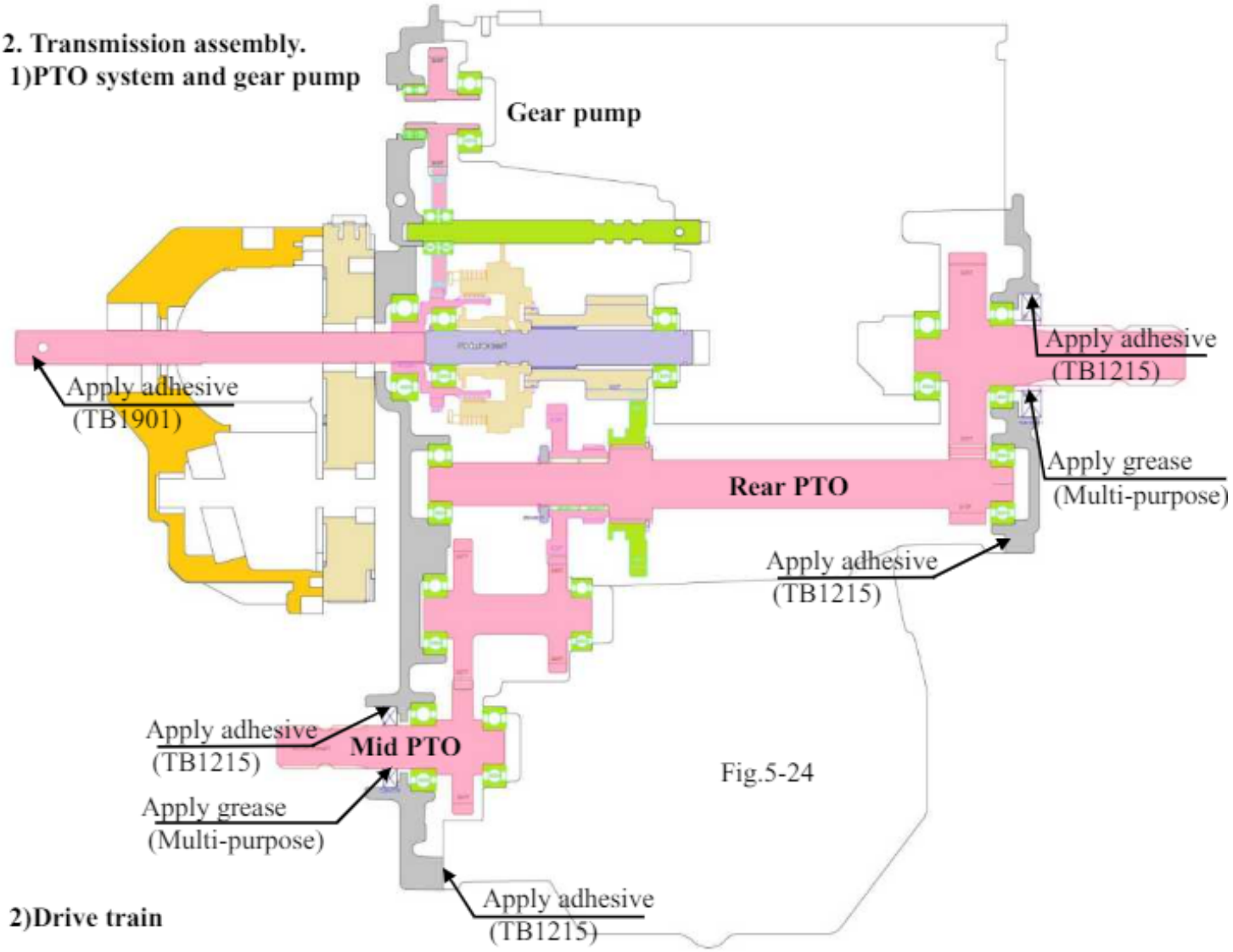


Fig.5-24

2)Drive train

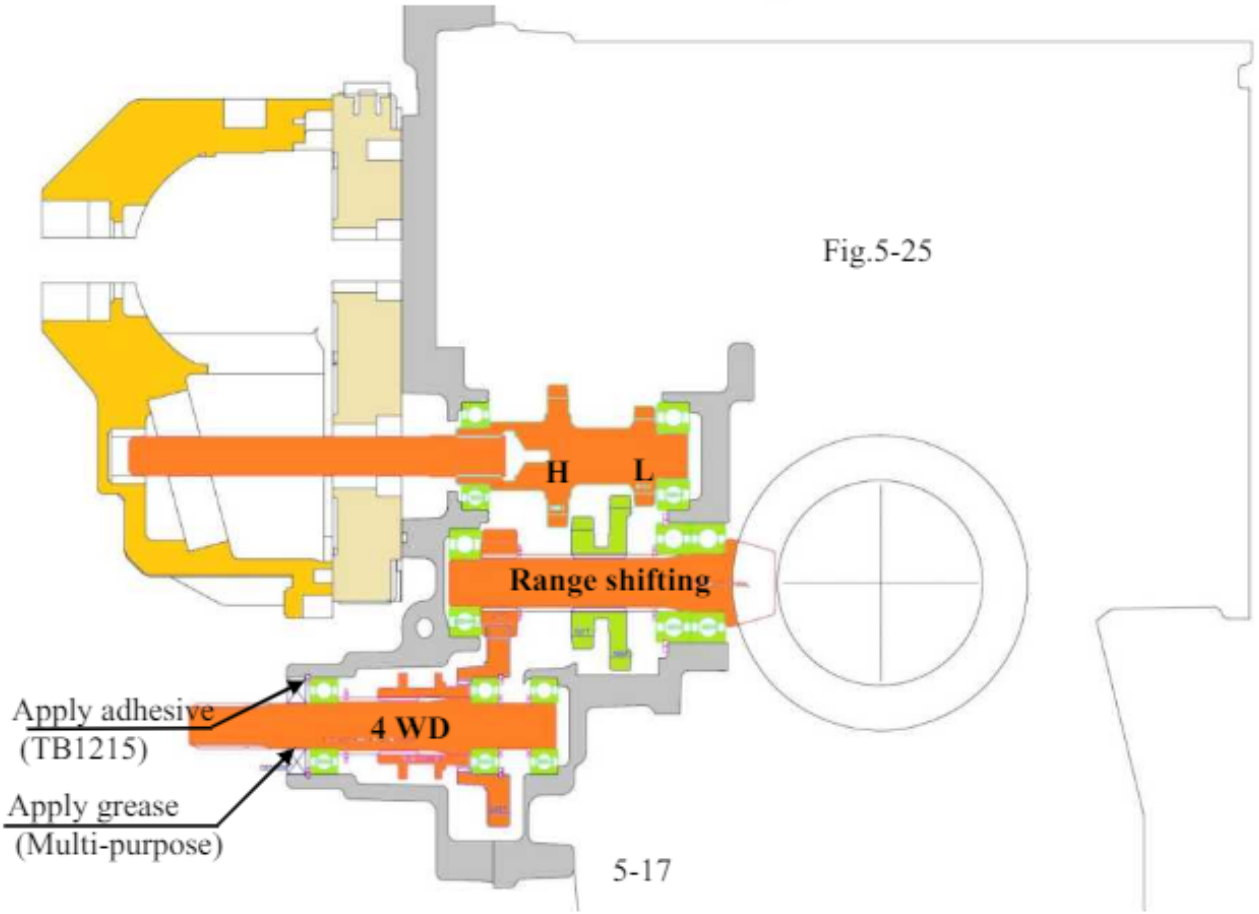


Fig.5-25

3) Rear axle assembly

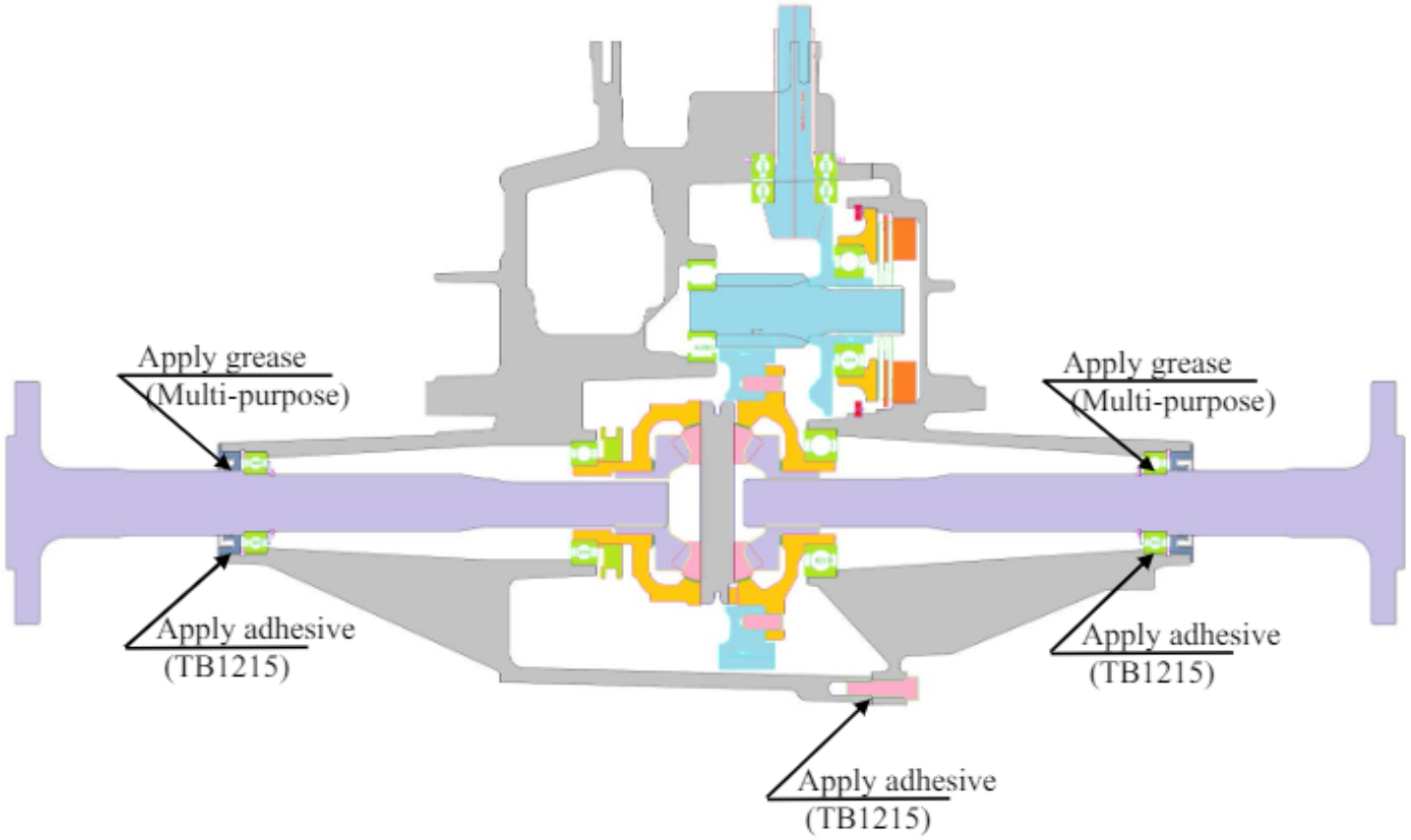


Fig.5-26

SECTION 4. TROUBLESHOOTING

1. WHEEL DRIVE SYSTEM

Problems	Causes	Countermeasures
Transmission makes noise in neutral	Insufficient or improper lubricant	Replenish or replace
	Excessive splines of change shaft, spline hub, etc	Replace
	Worn or broken bearings	Replace
	Slide couplings interfering with the gears due to worn or deformed shifters	Replace
Gears make a noise when shifted.	Improperly disengaged clutch	Repair or replace
	Wear in width of gears, spline hub, collars, etc	Replace
	Defective Change shift fork	Replace
Gears disengage by themselves	Broken shifter springs	Replace
	Wear in width of gears, spline hub, collars, etc	Replace
	Worn shifters	Replace
Gears do not engage or disengage	Improper disengaged shift lever	Repair or replace
	Gears are locked due to foreign matter between them	Remove the foreign matter

2. PTO DRIVE SYSTEM

Problem	Causes	Counter measures
PTO does not spin with PTO shifted to ON	PTO shift lever is in neutral	Shift lever positively to ON
	Defective PTO switch	Replace
	Clogged PTO hydraulic line	Wash clean, Replace
	Poor Pump	Replace
	Defective PTO solenoid valve	Replace
PTO spins but does not produce sufficient torque.	Worn clutch disc	Replace
	Broken or fatigues seal ring at clutch sleeve	Replace
	Loose joint or broken O-ring of delivery oil	Retighten or replace
	Poor pump	Replace
	Clogged PTO hydraulic line	Wash clean
PTO does not stop when PTO switch is shifted to OFF	Defective PTO solenoid valve	Replace
	Poor PTO valve (Contamination)	Wash clean
	Broken clutch piston return spring	Replace
	Poor switch	Replace
PTO follows too much when PTO switch is shifted to OFF	Improper oil	Replace
	Insufficient warming up	Let tractor warm up sufficiently
	Poor PTO clutch brake	Replace
	Weak or broken piston return spring	Replace
	Poor PTO valve (Contamination)	Wash clean
	Deflected clutch plate	Replace

CHAPTER 6
FRONT AXLE

SECTION 1. GENERAL DESCRIPTION---------- 6-1

SECTION 2. SPECIFICATIONS---------- 6-2

SECTION 3. DISASSEMBLY,INSPECTION,AND REASSEMBLY-- 6-3

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Chapter 6 Front axle(4WD)

1. GENERAL DESCRIPTION

The 4WD front axle is a center pivot type. The front wheel drive mechanism is incorporated as a part of the axle.

The front wheel drive power is taken off the rear transmission and transmitted to the differential in the front axle where the power is divided into right and left and to the respective final cases.

In the final cases, the transmitted revolution is reduced by the bevel gears to drive the front wheel.

The 4WD mechanism with bevel gears provides wider steering angle and greater durability.

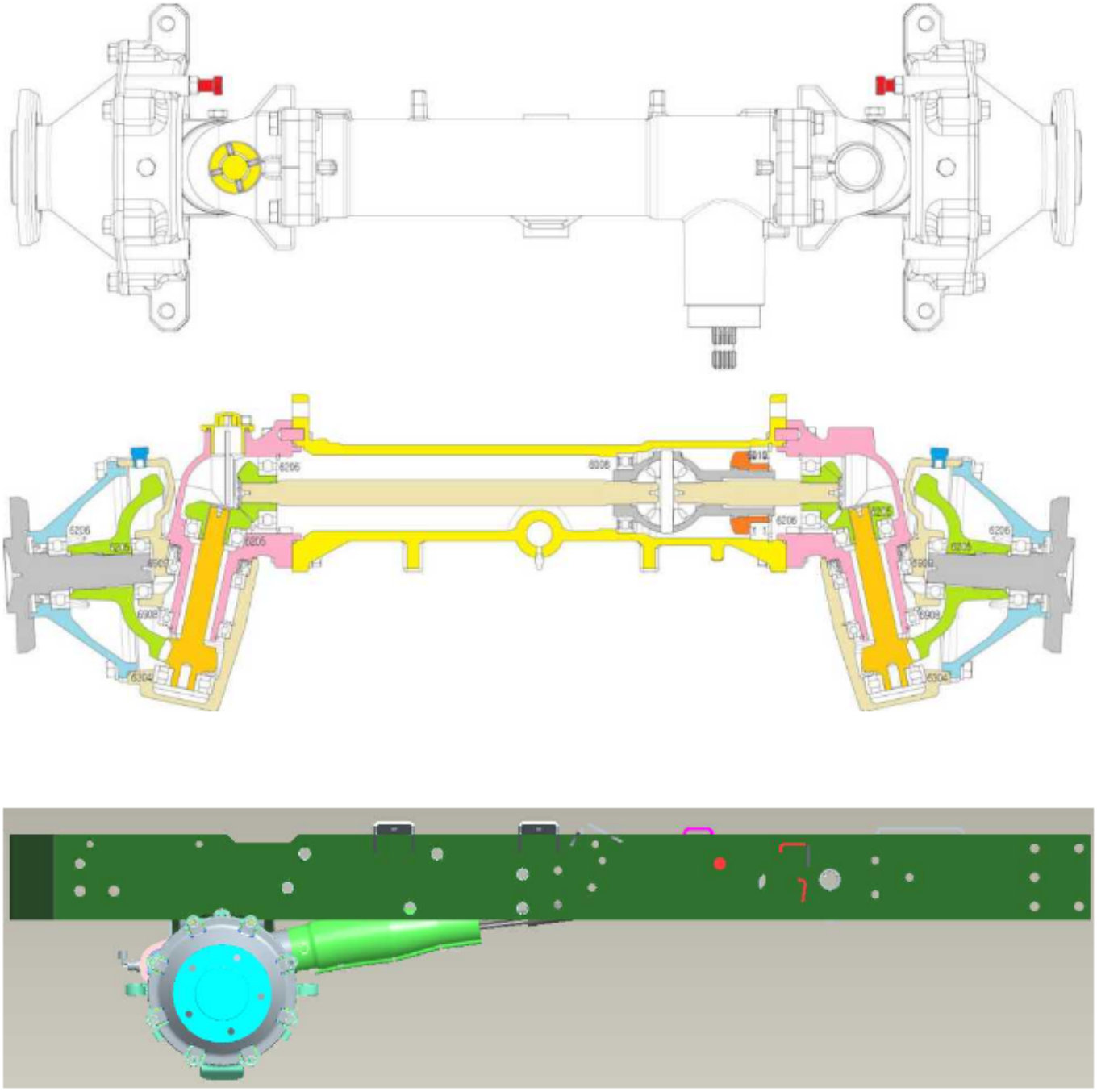


Fig 6-1

SECTION 2. SPECIFICATIONS

		eMax S20 HST
Wheel alignment	Toe-in (mm)	2~6
	Camber	3°
	Caster	0°
	King pin	12°
Front axle	Pivot Pin Diameter (mm)	Φ22
	Pivot bush (mm)	Φ22xΦ25xL25
	Housing Inner Diameter (mm)	Φ25
	Front wheel steering angles	LH : 50˚, RH : 45˚

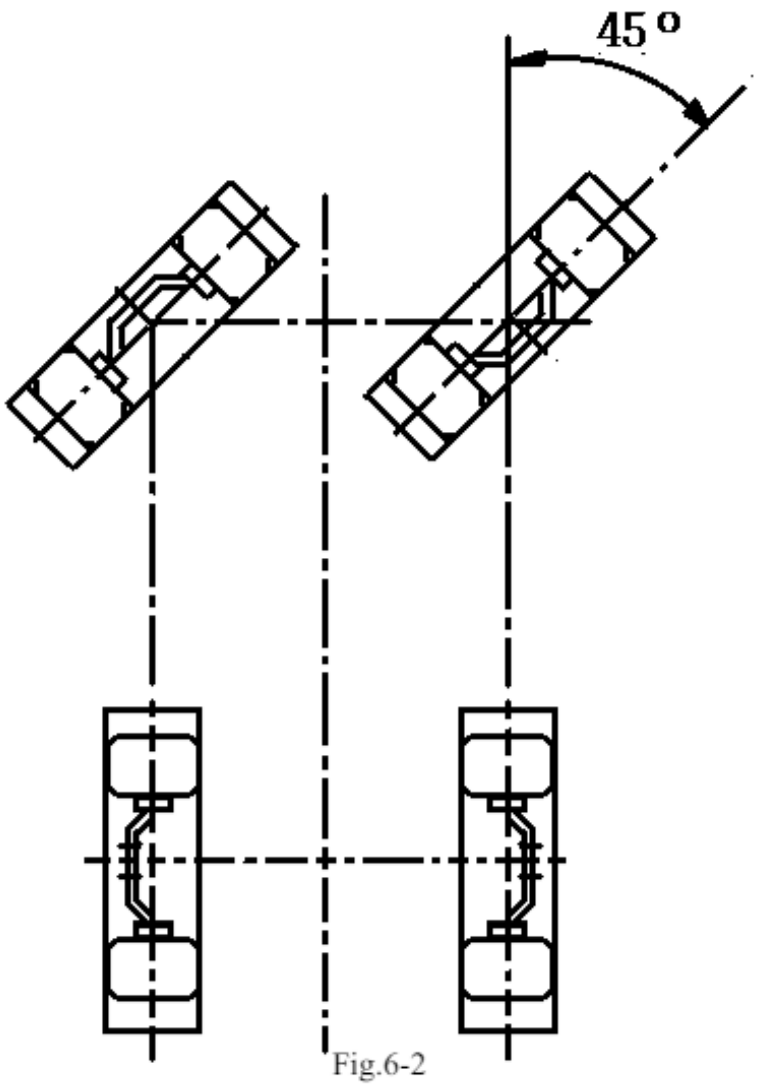


Fig.6-2

SECTION 3. DISASSEMBLY, INSPECTION AND REASSEMBLY

1. PIVOT PIN

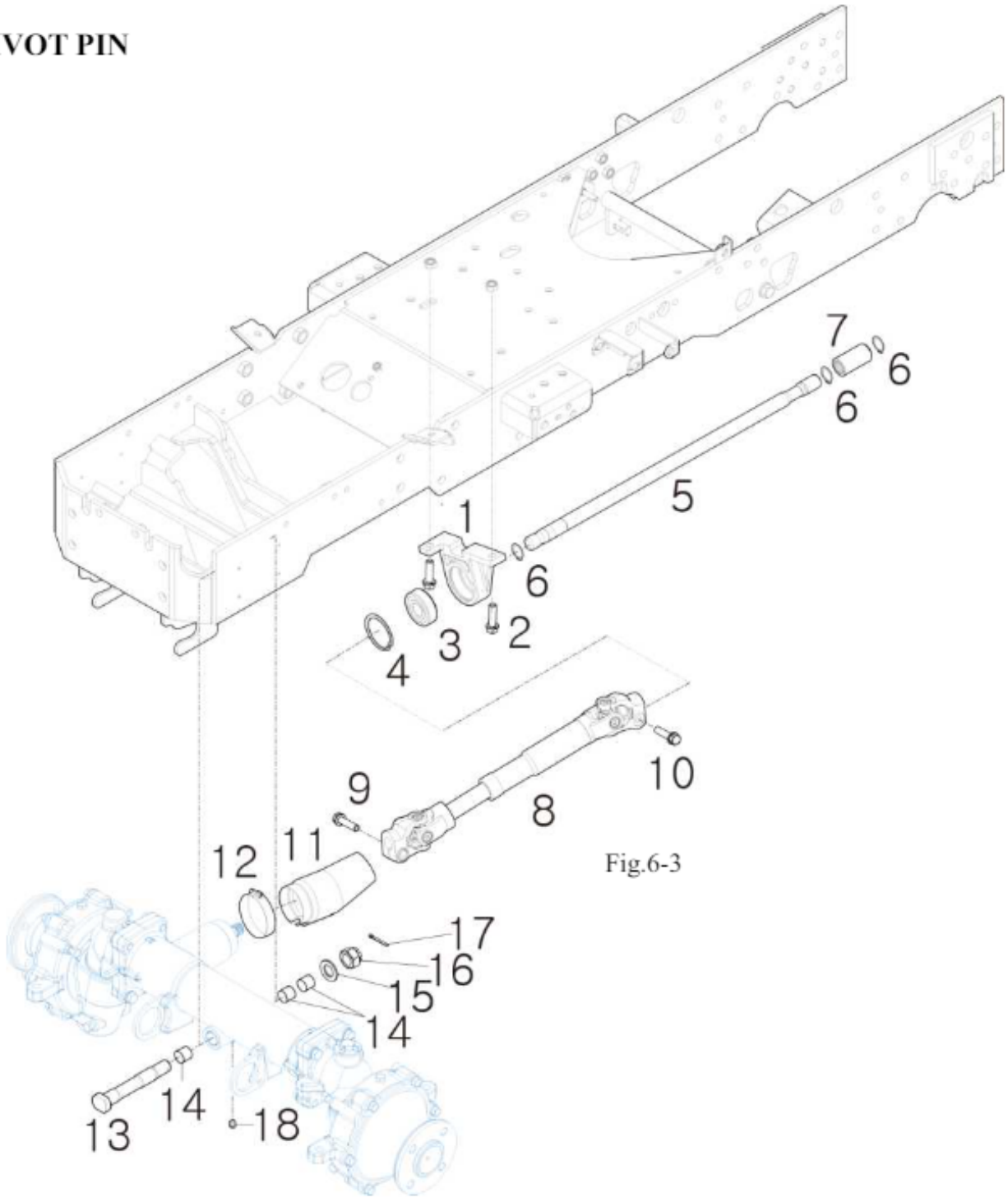


Fig.6-3

1.SUPPORT , 4WD ASSY 2.BOLT , HEX/S 3.BEARING , BALL 4.C-RING , HOLE 5.SHAFT , PROPELLER
6.C-RING , SHAFT 7.COUPLING 8.4WD UNIVERSAL JOINT SHAFT ASSY 9.BOLT , HEX/S
10.BOLT , HEX/S 11.COVER, 4WD 12.BAND CLAMP 75 13.PIN 14.BUSH(22X25X25)
15.WASHER , PLAIN 16.NUT , HEX SLOT & CASTLE 17.PIN , SPLIT 18.NIPPLE , GREASE/A-PT

1.1 DISASSEMBLY

1) Dismount the front axle assembly by referring to the pertinent paragraph in chapter 2.
2) Disconnect the steering hoses (LH, RH).
3) Suspend the front axle bracket with a chain.
4) Remove the right and left tie rods if necessary.
5) Remove the 4WD cover and joint comp.
   Pull out the pin, split in Fig. 6-3.
6) Remove the nut, hex slot & castle.
7) Draw the front axle assembly from the front axle bracket by holding it with crane.

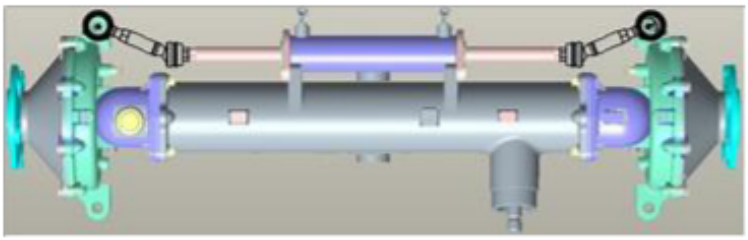


Fig.6-4

1.2.INSPECTION

1) FRONT AXLE BUSH BORE DIAMETER
   Measure the bore diameter of the bush in the front axle housing at the pin contact point with a micro-meter or vernier calipers.
   If the measured value exceeds the usable limit, replace the bush or the pin in front axle housing.

	Inner
Standard value as assembled	Ø22
Usable limit	Ø23

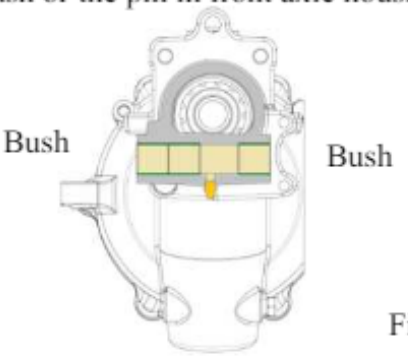


Fig.6-5

2) FRONT AXLE PIN DIAMETER
   Measure the diameter of the pin at bush contact point with a micro-meter or vernier calipers.
   If the measured value is less than usable limit, replace the pin.

	Pin
Standard value as assembled	Ø22
Usable limit	Ø21.8

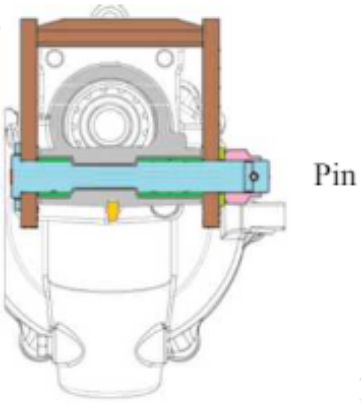


Fig.6-6

3) Worn or damaged part, it should be replaced.

1.3 REASSEMBLY

Reassemble the parts in reverse order of disassembly, following these instructions.

1) When installing the bushes, abide by the following precautions.
2) Clean the surface in the front axle housing which the bush is located ahead of time.
3) Use an installer and press in the bush on a press until the bush reaches at stopper position of housing.
4) The bore surface of bush should be coated with grease.
5) Install the front axle assembly to the front axle bracket by the pin.

6) Install the collar and tighten the nut completely.
7) Lift the front axle bracket with a hydraulic jack to get the wheels of the ground.
8) Loosen the nut within turning 1/2 in order to roll the front axle assembly freely while the wheels are still off the ground, move the axle on the center pivot pin as a final check.
9) Install the split pin that it should be bent as shown in the picture below.
10) Install the grease nipple.
11) Fill the grease nipple with the multi-purpose grease sufficiently.

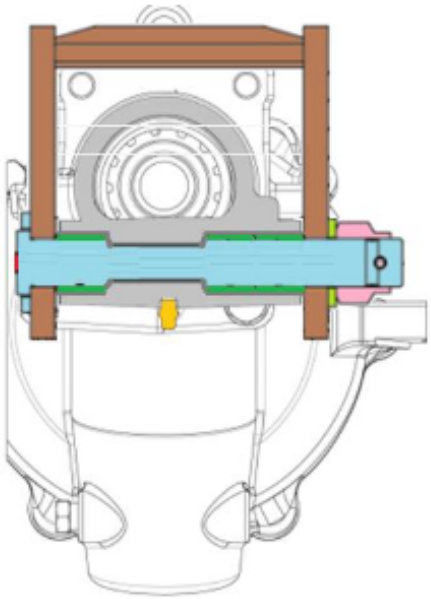


Fig.6-7

Note : Slanted or forced installation of the bush should be avoided, and the bore surface of the bush should not be damaged.
Note : Pay particular attention to the installed direction of thrust collar that is with the sharply-edged face turned towards the nut.

12) When the tie-rods are reinstalled, the toe-in should be adjusted. At the same time, the steering angles of the both wheels should also be adjusted.
13) Be sure the dimension C and D is same size and adjust E and F as same dimension (B-A : 2~6mm)

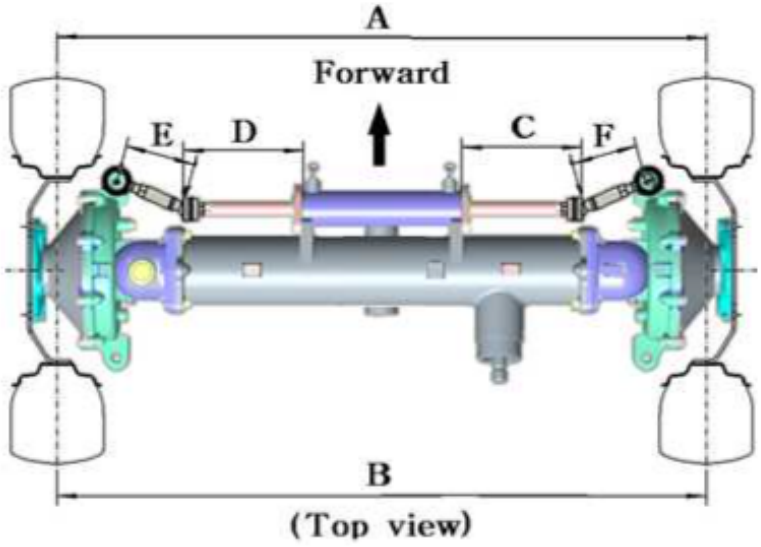
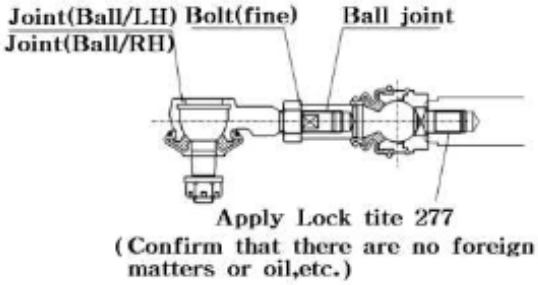


Fig.6-8

Reinstall the ball joint as shown in picture. if removed.



Tightening torque(M14x1.5p) : 9~12kg.m

Fig.6-9

2. FRONT DIFFERENTIAL

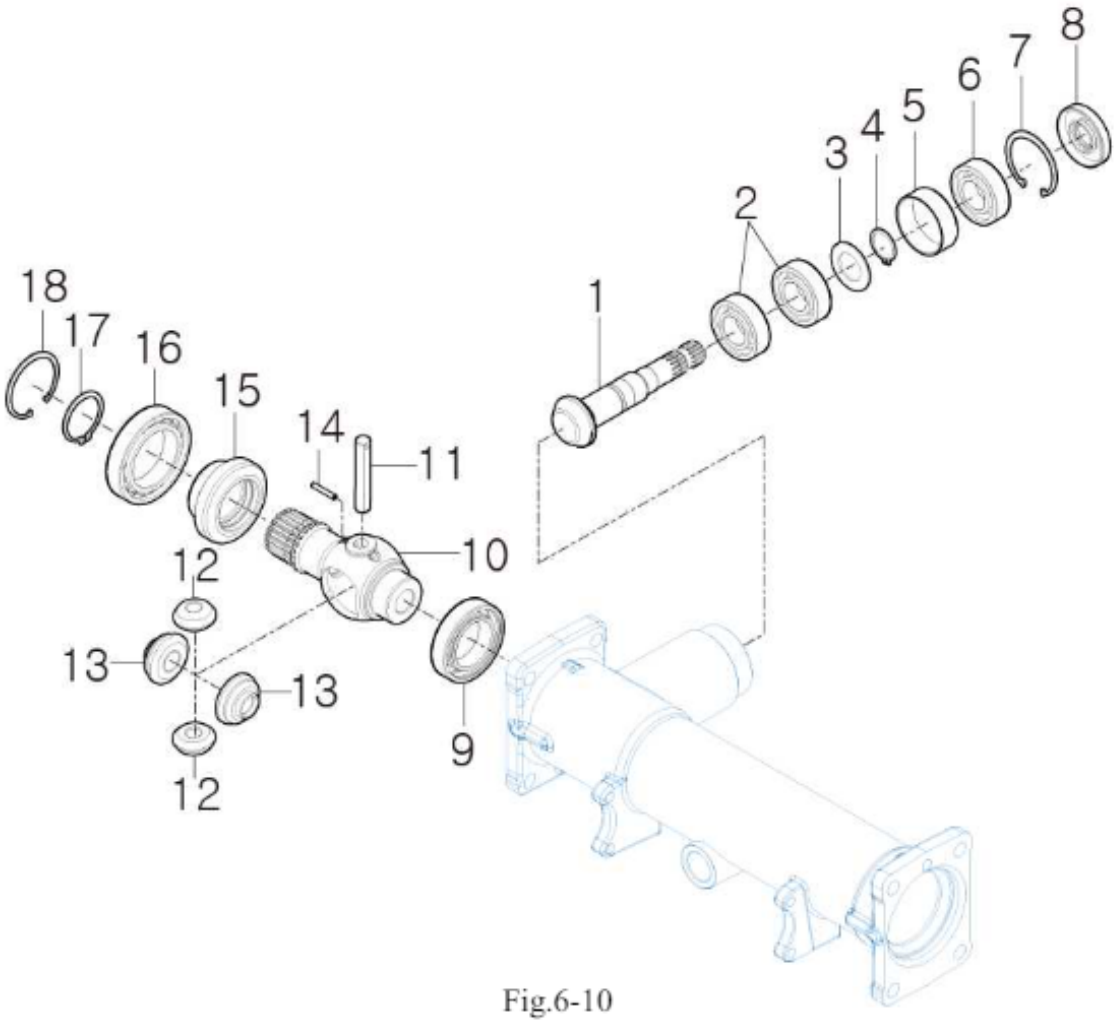


Fig.6-10

1.PINION , BEVEL 9T	2.BEARING , BALL 6205	3.WASHER , 25X42X2	4.C-RING , SHAFT 25
5.COLLAR , 48X52X17	6.BEARING , BALL 6205	7.C-RING , HOLE 52	8.SEAL , OIL
9.BEARING , BALL 6008	10.CASE , FR DIFF	11.SHAFT , DIFF PINION	12.PINION , DIFF 11T
13.GEAR , DIFF 15T	14.PIN , SPRING 4x25	15.GEAR , BEVEL 18T	16.BEARING , BALL 6010
17.C-RING , SHAFT 40	18.C-RING , HOLE 80		

2.1 DISASSEMBLY

1) As concerns operation prior to removal of the front axle, refer to the paragraph covering disassembly of the center pivot.
2) Remove both wheels if necessary.
3) Remove the drain plug from the final case and drain oil from the final case.
4) Remove the final case assembly (RH) from the front axle assembly.

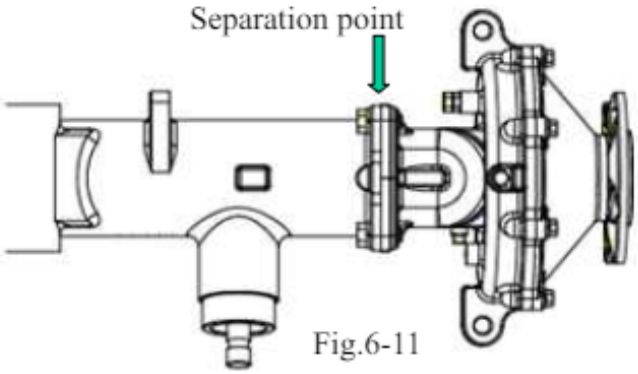


Fig.6-11

5) Remove the oil seal, pull out the snap rings.
6) Pull out the pinion shaft assembly.
7) Pull out the differential case assembly as shown in the picture.

Note : The number of shims and collars installed and the shimming thickness should be noted for later reference.

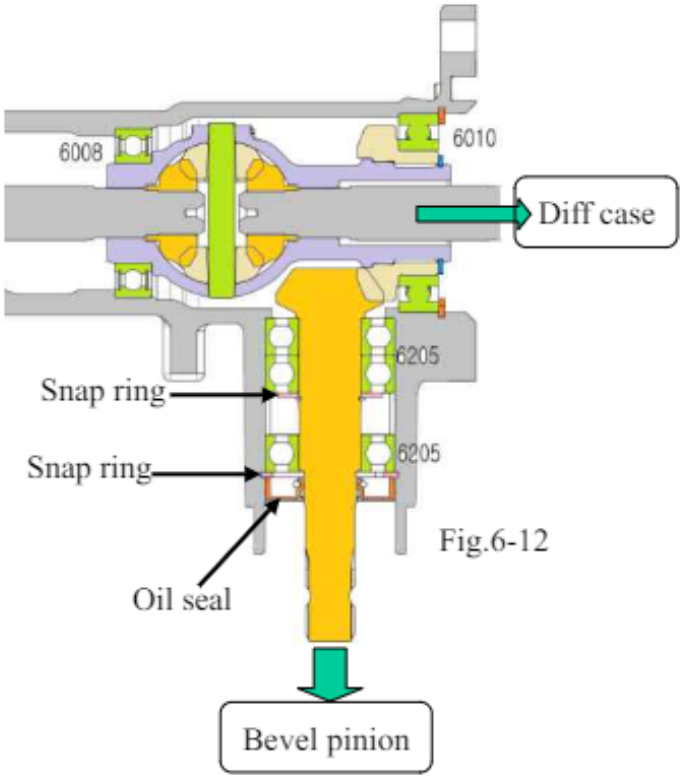


Fig.6-12

6) Remove the bearings, spacer collar
7) Remove the C-ring and washer and bearings.

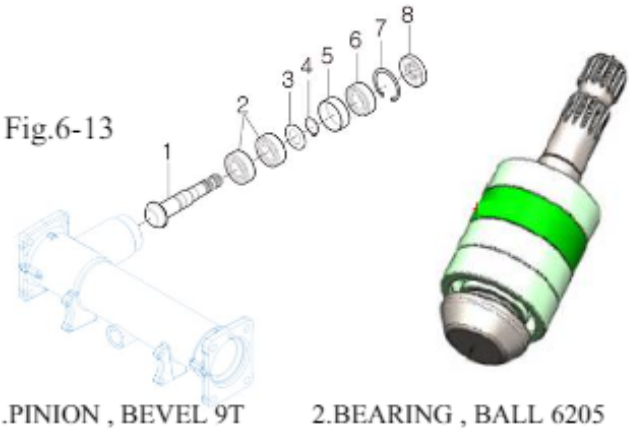


Fig.6-13

1.PINION , BEVEL 9T
2.BEARING , BALL 6205
3.WASHER , 25X42X2
4.C-RING , SHAFT 25
5.COLLAR , 48X52X17
6.BEARING , BALL 6205
7.C-RING , HOLE 52
8.SEAL , OIL

8) Remove snap ring (# 18).
9) Remove the differential gear assembly.
10)Remove the snap ring and bearing and bevel gear and bearing(9).
11) Remove the spring pin(14), shaft(11) and diff-gears.

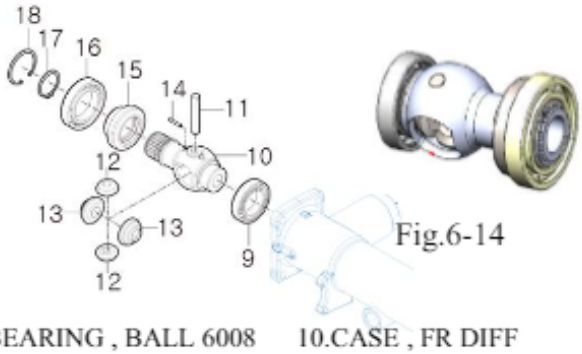


Fig.6-14

9.BEARING , BALL 6008
10.CASE , FR DIFF
11.SHAFT , DIFF PINION
12.PINION , DIFF 11T
13.GEAR , DIFF 15T
14.PIN , SPRING 4x25
15.GEAR , BEVEL 18T
16.BEARING , BALL 6010
17.C-RING , SHAFT 40
18.C-RING , HOLE 80

Note : Discard the removed spring pin and oil seal and install a new pin and Oil seal when reassembled, because this pin and oil seal is apt to be damaged when removed.

2.2 INSPECTION

1) visually check the bearing surfaces of the bevel pinion and ring gear teeth.

Note : The bevel pinion and the ring gear is replaced as a pair.

2) Seriously worn or damaged parts should be replaced.

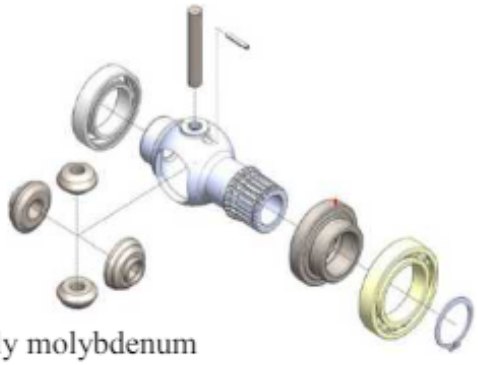
2.3 REASSEMBLY

Reassembly the parts in reverse order of disassembly, following these instructions.

1)Each friction surface should be coated with grease in advance.
2)The bevel pinion and the ring gear make a distinct pair after a mesh adjustment performed at the factory. Consequently, when reassembling the pair, be sure to pair parts with a same reference number.

Note : Securely be sure that the snap ring should be seated in the groove. Pay attention to fit the snap ring to the correct direction

3) FRONT DIFF CASE
a. When installing diff. gears, apply fresh Molybdenum grease ahead of time.
b. Apply fresh Molybdenum grease to teeth of diff-pinion and diff-side gear.
c. Each parts should be washed clean ahead of time. There should be no sharp edge to the surface of all parts.
d. When assembling the spring pin, pay attention to the correct direction.



Apply molybdenum grease(TB1901)

Fig.6-16

4) 4WD shaft assembly
a. Install the snap ring(4) and bearing(3) in the 4wd support(1).
b. Install the 4wd support assembly with bolts(2) to front axle bracket.
c. Install the shaft(5) after installing the snap ring(6) and coupling(7)..
d. Install the clip and 4wd cover to 4wd joint comp.
e. Install 4wd joint comp to the front axle assembly.
f. Install the 4wd joint to the shaft with bolt(9, 10).
g. Install the cover with clip(12).

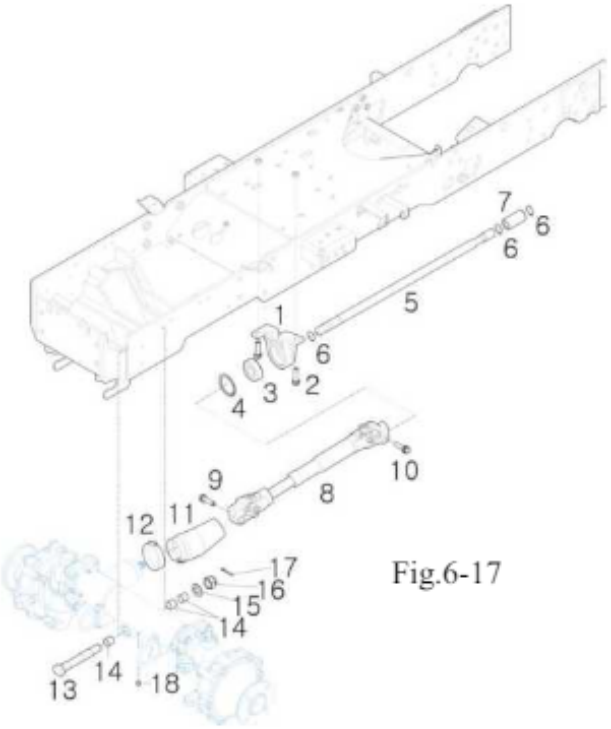
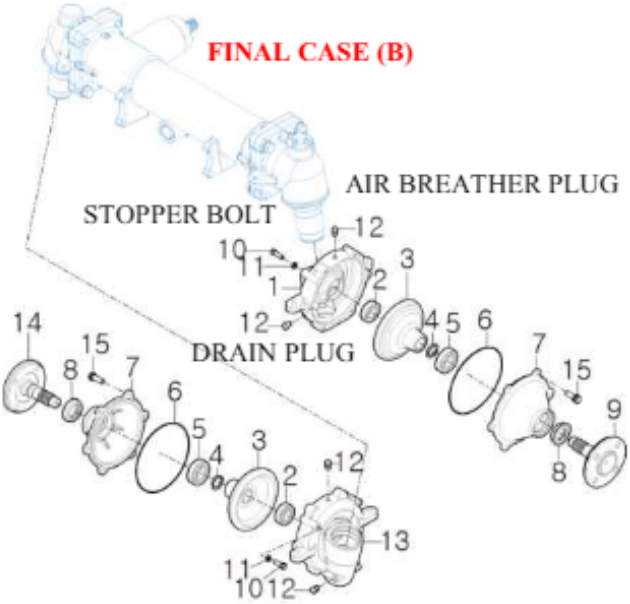
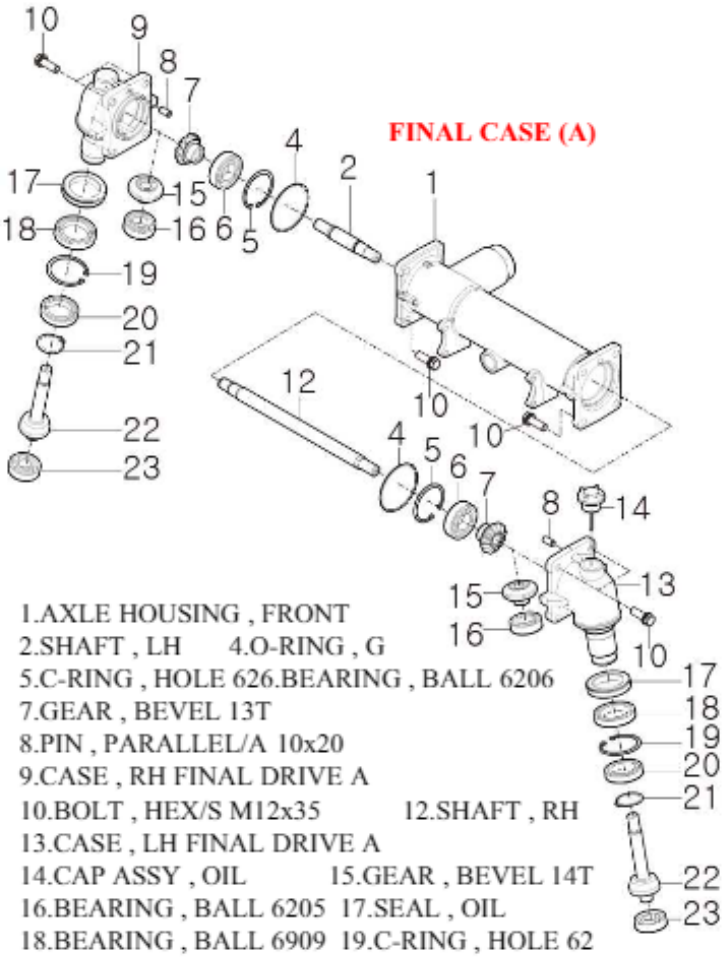


Fig.6-17

1.SUPPORT , 4WD ASSY 2.BOLT , HEX/S
3.BEARING , BALL 4.C-RING , HOLE
5.SHAFT , PROPELLER 6.C-RING , SHAFT
7.COUPLING
8.4WD UNIVERSAL JOINT SHAFT ASSY
9.BOLT , HEX/S 10.BOLT , HEX/S
11.COVER, 4WD 12.BAND CLAMP 75
13.PIN 14.BUSH(22X25X25)
15.WASHER , PLAIN 16.NUT , HEX SLOT & CASTLE
17.PIN , SPLIT 18.NIPPLE , GREASE/A-PT

3. FINAL CASE





1.CASE , LH FINAL DRIVE B
2.BEARING , BALL 3.GEAR , BEVEL 35T
4.WASHER , 27X36X3 5.BEARING , BALL
6.O-RING(S) 7.COVER , WHEEL SHAFT
8.SEAL , SHAFT 9.SHAFT , WHEEL
10.BOLT , HEX M10x30 11.NUT , HEX/3 M10
12.PLUG , HEX-SOCKET 13.CASE , RH FINAL DRIVE B
14.SHAFT , WHEEL 15.BOLT , HEX/S M10X30

1.AXLE HOUSING , FRONT
2.SHAFT , LH 4.O-RING , G
5.C-RING , HOLE 626.BEARING , BALL 6206
7.GEAR , BEVEL 13T
8.PIN , PARALLEL/A 10x20
9.CASE , RH FINAL DRIVE A
10.BOLT , HEX/S M12x35 12.SHAFT , RH
13.CASE , LH FINAL DRIVE A
14.CAP ASSY , OIL 15.GEAR , BEVEL 14T
16.BEARING , BALL 6205 17.SEAL , OIL
18.BEARING , BALL 6909 19.C-RING , HOLE 62
20.BEARING , BALL 6908 21.C-RING , SHAFT 40
22.GEAR , BEVEL 9T 23.BEARING , BALL 6304

Fig.6-18

3.1 Disassembly

1) Drain oil from the final case (LH/RH) by removing the drain plug(12) and air breather plug(12).
2) Remove the tie rod or the tie rod end.
3) Remove the final drive case A assembly(9), O-ring, pull out the shaft(2, 12) and bevel gears, bearings.
4) Remove the wheel shaft cover (7) with the wheel shaft, bearings and the bevel gear and O-ring.
5) Pull out the snap ring(21).
   Separate final drive case B from final drive case A.

Note : Pay attention to the residual oil.
Be careful not to damage or deform the O-ring, oil seal and snap ring.

6) Pull out the bearing and snap ring(19).
7) Pull out the shaft(22) and the bearing.
8) Remove the bevel gear (15).
9) Extract the bearing by using a bearing puller.
10) The other parts are removed as shown in the picture above.

3.2 Inspection

Before and after disassembly, inspect each part for serious worn or damaged part and replace if necessary.
Inspect bearings for abnormalities in rotation such as irregularity, hitching by turning them with pressure applied by hand. Replace defective ones.

3.3 REASSEMBLY

Reassemble the parts in reverse order of disassembly, following these instructions.

1) Install the bevel gear with bearing together and Install the snap ring in the final case A.
2) Install the unitized seal and bearing by using the special tool.

Note : Apply the adhesive on the unitized seal which matching the case (TB1215).
Apply the multi-purpose grease sufficiently on the outer surface all.
When installing the unitized seal, apply force only to the inner circumference of the seal as shown in picture to avoid deformation.

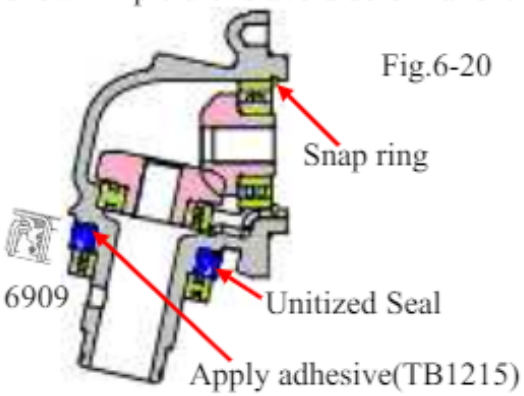


Fig.6-20

Note : Install the seal carefully, assuring that their lips are not turned over.

3) Install the bearing(6304), shaft, bearing(6908), and snap ring in the final drive case B.

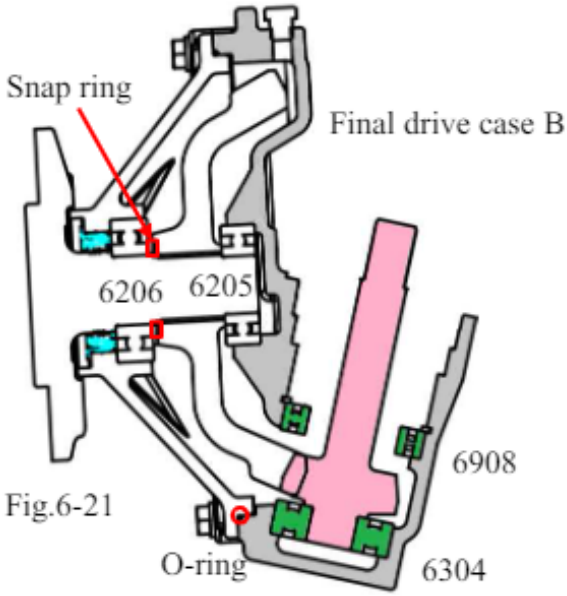


Fig.6-21

Note : Every snap ring should be seated securely in its groove. Pay attention to correct direction.

Note : Be careful not to mix final drive case(LH/RH).

4) Install the final drive case a to final drive case B.
5) Install the snap ring(C-40).
6) Install the bearing and the sealant to the wheel shaft cover.
Apply force only to the outer circumference of the seal as shown in the picture to avoid deformation.

Note : Apply adhesive (TB1215) on the outer surface of the seal ahead of time.

Note : Apply the grease on the rib of sealant and wheel shaft sufficiently.

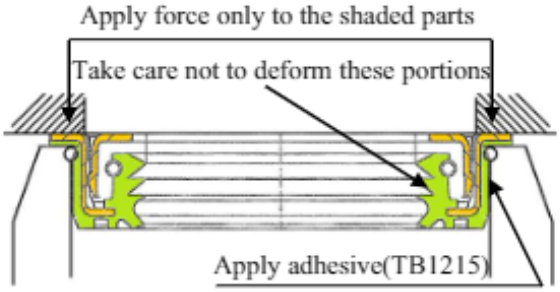


Fig.6-22

7) Install the wheel shaft and the bevel gear and bearing(6205).
8) Install the O-ring after applying the grease.
9) Install the parallel pins to the final case B.
10) Install the wheel shaft assembly to the final drive case (B) assembly.
11) Assemble the O-Ring to the final drive assembly.
12) Assemble the final drive assembly to axle housing.

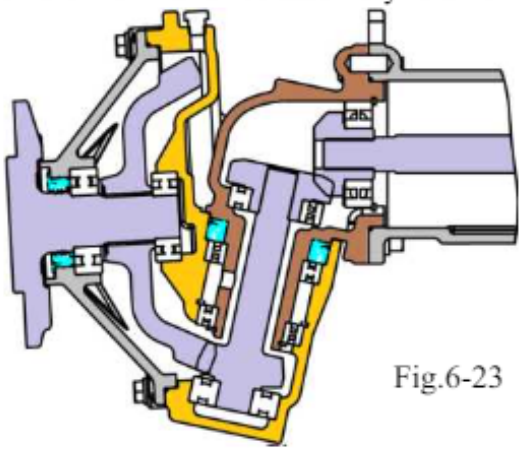


Fig.6-23

Note : The installed wheel shaft should turn smoothly.

13) The steering angle is set up as shown in the below picture.

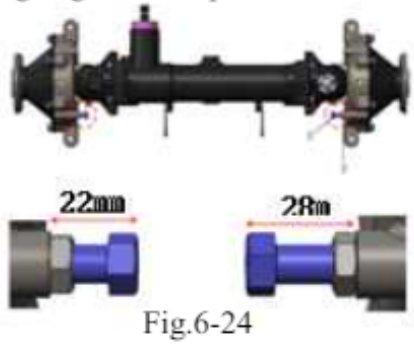


Fig.6-24

PROBLEMS AND PROBABLE CAUSES	COUNTERMEASURES
● Steering wheel hard to turn	
1)Too low tire inflation 2)Broken thrust bearing 3)Stuck or broken ball joint of tire-rod end 4)Seizure or poor lubrication of axle end bush	Inflate to specified value Replace Grease or replace Grease or replace
● Vibrating or pulling steering wheel	
1)Unbalanced wheels 2)Wheel deflation 3)Unequal diameter of both tires 4)Loose,worn,or damaged wheel axle bearing 5)Loose,worn,or damaged wheel steering wheel shaft 6)Worn final case bush 7)Loose final case-front axle tightening bolt 8)Loose front wheel(tire)tightening nuts1)	Adjust balance Repair or replace Adjust inflation or replace Repair or replace Retighten or replace Replace Retighten Retighten
● Steering wheel tends to turn to the right or left while traveling on straight paved road.	
1) Deflected wear of tire 2)Different tire diameters 3)Damaged final case bearing	Replace Adjust inflation or replace Replace
● Excessive or eccentric wear of tire	
1)Improper tire inflation 2)Worn front wheel shaft bearing 3)Poorly adjusted toe-in 4)Front wheel drive is always engaged	Adjust Replace Readjust correctly:2-6mm Engage FWD only when required
● Noise	
1)Loose fasteners 2)Worn or damaged final case bearing 3)Worn bush 4)Wear or poor movement of tie-rod end 5)Excessive backlash of differential and bevel gear	Tighten correctly to specified torque Replace Replace Lubricate or replace Adjust
● Different steering angles in both directions	
1)Lengths of RH and LH tie-rods are different	Adjust

CHAPTER 7
REAR AXLE AND BRAKES

SECTION 1. GENERAL DESCRIPTION---------- 7-1

SECTION 2. SPECIFICATIONS---------- 7-1

SECTION 3. DISASSEMBLY,INSPECTION,AND REASSEMBLY– 7-2

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1.1 Disassembly---------- 7-3

1.2 Inspection---------- 7-5

1.3 Reassembly---------- 7-6

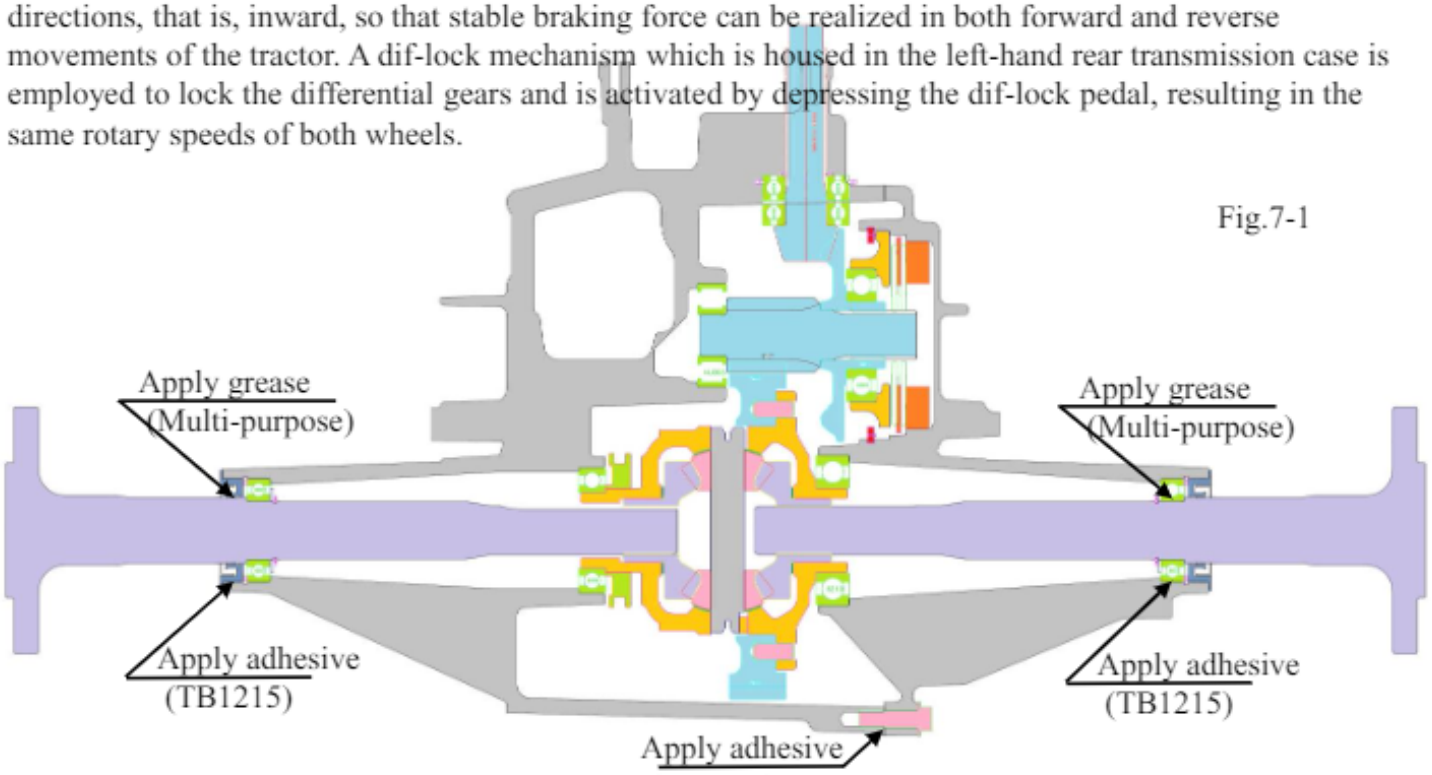
SECTION 4.TROUBLE SHOOTING---------- 7-7

Chapter 7. Rear axle and brakes

SECTION 1. GENERAL DESCRIPTION

The rear axle system is of the central axle type, which contains the final reduction gears, differential gears with diff-lock, and brakes. The power from the engine is transmitted to the right and left wheel pinions through the differential gears, and reduced in the revolution to the rear wheels by the wheel gears. A wet multi-Disc, mechanical operated brake system is employed. The brake has 2 friction plates and can produce significant braking force with excellent durability. The actuator work to push their friction plates in opposite directions, that is, inward, so that stable braking force can be realized in both forward and reverse movements of the tractor. A dif-lock mechanism which is housed in the left-hand rear transmission case is employed to lock the differential gears and is activated by depressing the dif-lock pedal, resulting in the same rotary speeds of both wheels.

Fig.7-1



SECTION 2. SPECIFICATIONS

MODEL			eMax S20 HST
Differential reduction gears		Type	Spiral bevel gear (10T/56T)
		Reduction ratio	0.178
Reduction gears		Type	Spur gear (7T/33T)
		Reduction ratio	0.212
Brake system	Friction Plate	Type	Wet, multi-disc, Mechanical operated
		Diameter	Φ65 x Φ109 mm
		Thickness	3.4±0.1 mm
		Number of plates	2
	Separator Plate	diameter	Φ62 x Φ110 mm
		Thickness	2.5±0.08 mm
		Number of plates	1

Separate the rear axle housing from the rear transmission referring to paragraph in Chapter 2

1. REAR AXLE HOUSING AND BRAKE SYSTEM

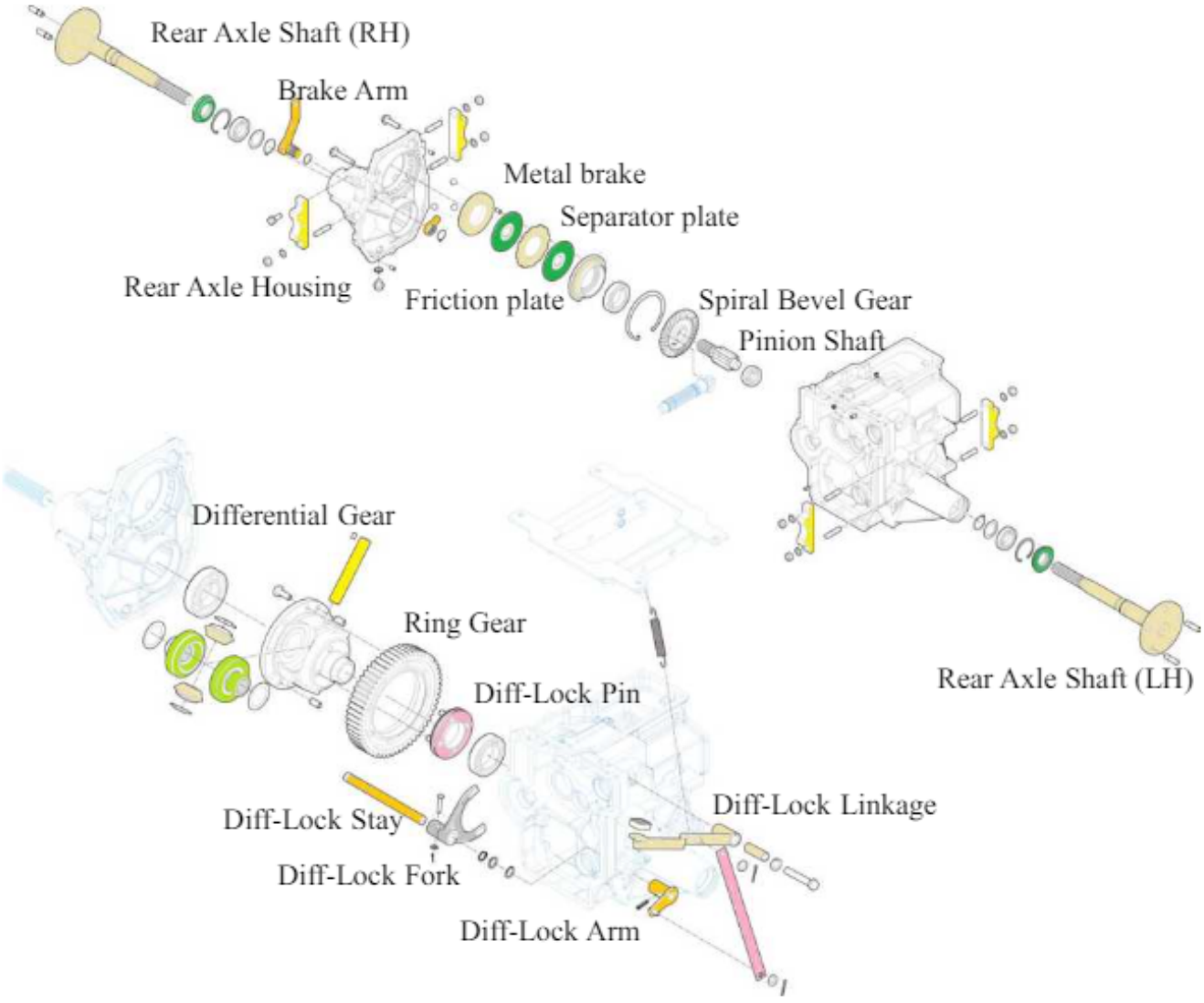


Fig.7-2

1.1 Disassembly

1) Removal of the brake rod linkage
2) Release the parking brake linkage.
3) Detach the spring(24) and the brake rod.
4) Remove the spring pin(16) and arm comp. and brake pedal.

Note : Be careful not to damage the bush.

5) Remove the parking brake rod comp(1).
6) Remove the parking brake rod comp(2).
7) Remove the parking brake pedal comp(6) and guide(5).
8) Remove the brake switch(23).

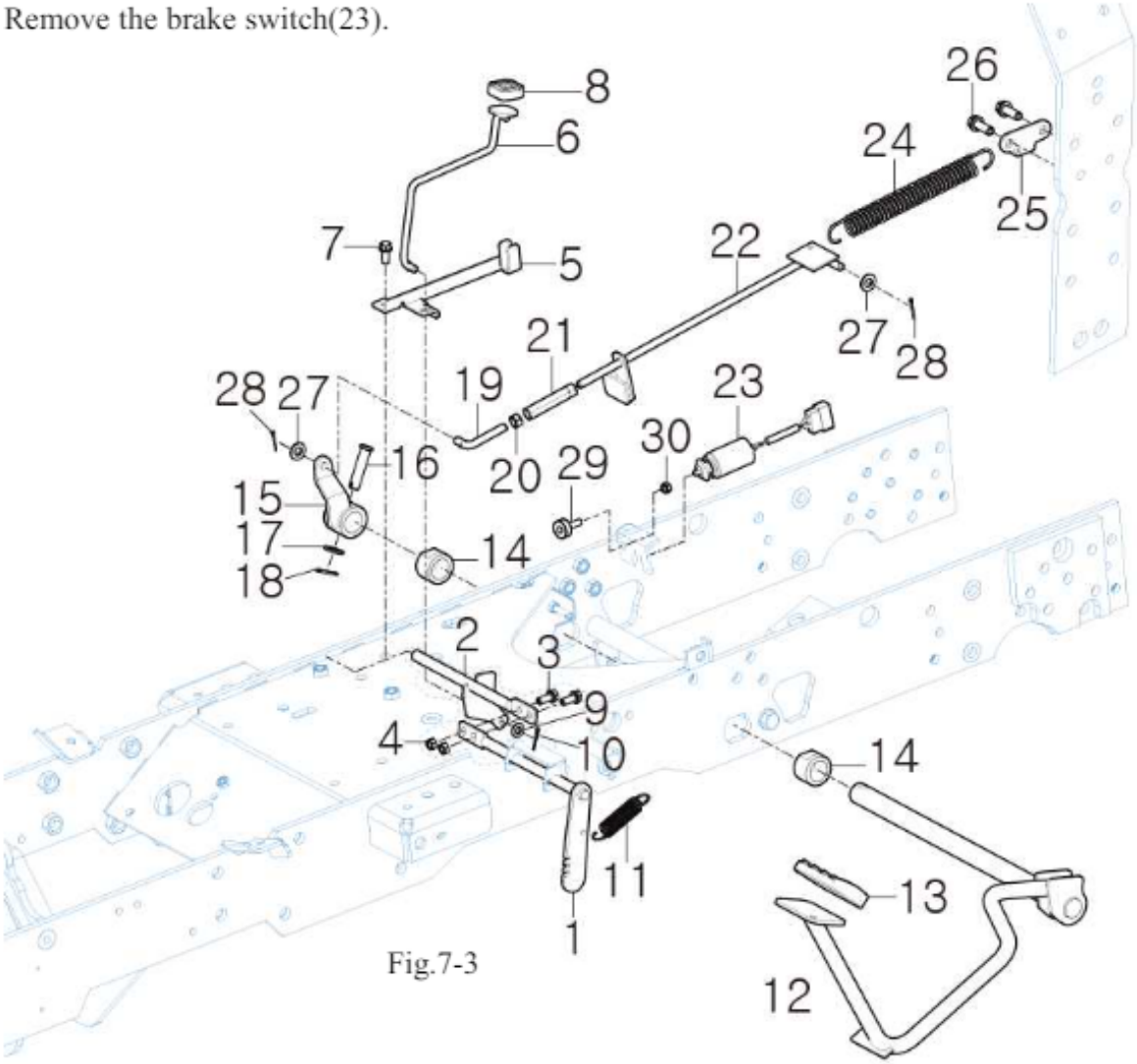


Fig.7-3

1.ROD COMP , PARKING BRAKE A	2.ROD COMP , PARKING BRAKE B	3.BOLT , HEX/SP M8x25
4.NUT , HEX/2 M8	5.BRACKET COMP , PARKING GUIDE	6.PEDAL COMP , PARKING BRAKE
7.BOLT , HEX/S M8x20	8.PAD	
9.WASHER , PLAIN M8	10.PIN , SPLIT	11.SPRING , RETURN
12.PEDAL COMP , BRAKE	13.PAD , BRAKE	14.HUB(25X38X25)
15.ARM COMP , BRAKE	16.PIN	17.WASHER , PLAIN M12
18.PIN , SPLIT	19.ROD , BRAKE FORWARD	20.NUT , HEX/2 M10
21.TURNBUCKLE , M10	22.ROD COMP , BRAKE REVERSE	23.SWITCH ASSY , BRAKE
24.SPRING	25.BRACKET	26.BOLT , HEX/S M10x30
27.WASHER , PLAIN M10	28.PIN D2.5x20	29.RUBBER , CUSHION B
30.NUT .HEX NORMAL /2		

9) Remove the rear axle housing assembly(1) from the rear transmission case.

Note : Extract the rear axle housing assembly with crane.

Remove the spur gear 10T (2) and the snap ring(4) and the spiral bevel gear and bearing and brake system.

Note : Don't forget the metal(LH/RH) and the balls.

Remove the snap ring(22) and the brake cam and brake arm(19).

10) Remove the sealant(27) and the snap ring(28).

Separate the shaft from the rear axle housing(1)

Remove the snap ring(31) and washer and bearing(29) from shaft.

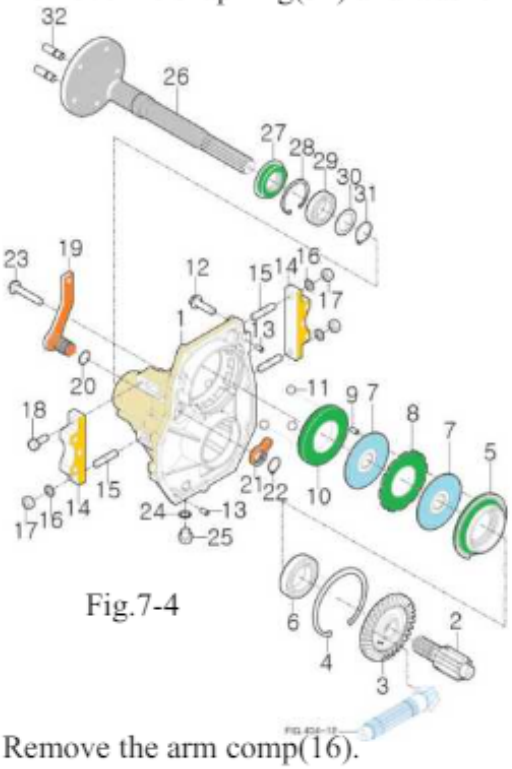


Fig.7-4

1.AXLE HOUSING , RR	2.GEAR , SPUR 10T
3.GEAR , SPIRAL BEVEL 33T	4.C-RING , HOLE
5.METAL , BRAKE	6.BEARING , BALL 6208
7.DISK , BRAKE	8.PLATE , SEPARATE
9.PIN , PARALLEL/A 8x16	10.PLATE , PRESSURE
11.STEEL , BALL	12.BOLT , HEX FLANGE M10x35
13.PIN , PARALLEL/A 8x16	14.BRACKET , MTG
15.BOLT , STUD/ M12x30	16.WASHER , SPRING M12
17.NUT , HEX/ M12	18.BOLT , HEX/ M12x30
19.ARM COMP, BRAKE	20.O-RING , P
21.CAM , BRAKE	22.C-RING , SHAFT 25
23.BOLT , HEX FLANGE M10x50	24.O-RING , P
25.PLUG , DRAIN (MAGNET)	26.SHAFT, RR WHEEL
27.SEAL , SHAFT 40	28.C-RING , HOLE 62
29.BEARING , BALL 6007	30.WASHER , 35X50X02
31.C-RING , SHAFT 35	32.WHEEL , STUD

11) Remove the arm comp(16).

Remove the differential gear assembly and diff-lock system.

Remove the spur gear 56T (11)

Remove other parts as shown in the below picture.

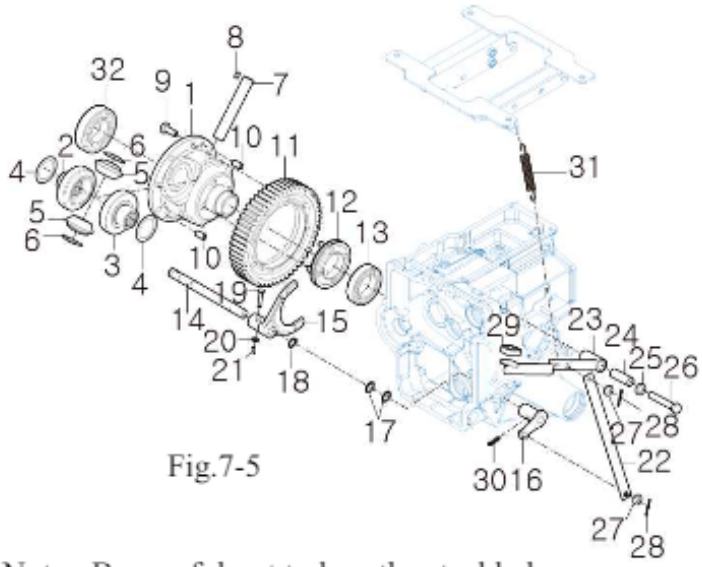


Fig.7-5

1.CASE , DIFF	2.GEAR , BEVEL 20T
3.GEAR , BEVEL 20T	4.THRUST WASHER , 38X52X01
5.PINION , DIFF 12T	6.WASHER , DIFF PINION
7.SHAFT , DIFF PINION	8.KEY 9.BOLT , HEX/S
10.PIN , PARALLEL/A	11.GEAR , SPUR 56T
12.SLEEVE COMP , DIFF LOCK	13.BEARING , BALL
14.SHAFT , DIFF LOCK	15.FORK , DIFF LOCK
16.ARM COMP , DIFF LOCK	17.O-RING , P
18.C-RING , SHAFT	19.PIN (6X32)
20.WASHER , PLAIN	21.PIN , SPLIT 22.LINK , DIFF
23.PEDAL COMP , DIFFLOCK	24.BUSH
25.WASHER , SPRING	26.BOLT , HEX
27.WASHER , PLAIN	28.PIN D2.5x20
29.PAD	30.PIN , SPRING
31.RETURN SPRING , CLUTCH	32.BEARING , BALL

Note : Be careful not to lose the steel bal.
It can jump out of the spring.

1.2 INSPECTION

1) Friction plates.
Replace the plates whose surfaces have been become glossy by carbonization or whose thickness exceeds the usable limit.

Standard thickness : mm (in)	3.4 (0.133)
Usable limit : mm (in)	3.1((0.122)

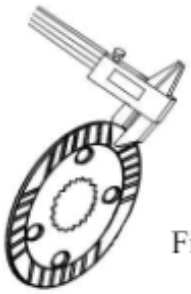


Fig.7-7

Note : Also replace those whose grooves have been worn out completely even if only on one side.

2) Metal brake and cover
Check the metal brake, and brake rod for abnormality. Replace defective parts. Replace the metal brake whose thickness exceeds the usable limit.

Standard thickness : mm (in)	14(0.55)
Usable limit : mm (in)	13.3(0.52)

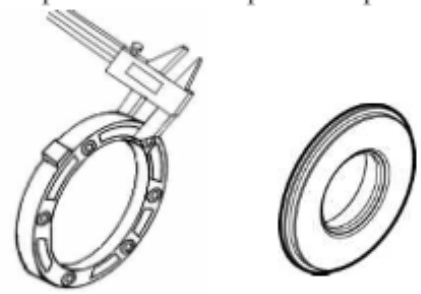


Fig.7-8

Note : Slight scratches on the friction surface can be corrected with sandpaper (#1000)

3) Separator plate
Measure the thickness and replace the plate whose thickness exceeds the usable limit or whose surfaces are damage.

Standard thickness : mm (in)	2.5±0.09 (0.098)
Usable limit : mm (in)	2.2(0.087)

Fig.7-9

4) Wheel shaft
Check the shaft for abnormalities like wear, damage, etc, and replace a defective one.

5) Bearings
Check them for abnormalities like hitching, irregularity etc in rotation after being washed clean. Replace defective ones.

6) Oil seals
Removed oil seal should be replaced with a new one when reassembled.

1.3 REASSEMBLY

Reassemble the parts in reverse order of disassembly, follow these precautions.

1) Make sure that brake metal, friction surfaces, etc of the brakes are free from matter such as dust, iron powder, etc. to avoid brake lining damage.
2) When installing the brake unit on the wheel pinion, friction plates and separator plates should be arranged in correct order.
3) Cam brake stopper ring should be seated to the groove and to the correct direction.
4) Replace the oil seal with new seal.
   Install the sealant and snap ring and bearing and washer and stopper ring to the shaft.
   Install the rear axle shaft assembly into the axle housing,
   and then install the stopper ring into the rear axle housing.
   Press the oil seal into the housing by applying force only to the circumference as shown in the figure.
5) press the wheel shaft after apply grease on the inner surface of the seal and shaft sufficiently.

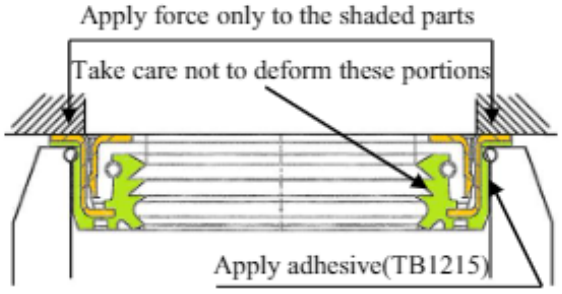


Fig.7-10

Note : Apply an grease on the rib of sealant and on the shaft sufficiently.
Note : When installing the brake disc, Disc plate and separator should be arranged in correct order.
Apply an grease to the oil seal and take care not to be damaged when installing to the brake cam.
Pay particular attention to the installation of the snap ring.
The assembled wheel pinion should rotate smoothly.

6) Install the steel ball and the brake metal and the brake disk plate and separator.
8) Install the brake cover with bearing and spiral bevel gear and stopper ring and pinion shaft..
9) Apply adhesive (THREE BOND 1215) to the contact surfaces of the rear housing and rear transmission case and then reassemble the rear housing by tightening the bolts to the specified torque.

Tightening torque (Bolts)	
M10x1.5P	3.3 ~ 4.5 Kgf.m (23.8 ~ 32.5lb.fts)

6) Install the diff-gears in the carrier after applying the molybdenum grease sufficiently.

Problem	Causes	countermeasures
1) Rear axle		
Noises	· Worn or damaged bearing · Worn gear or wheel shaft	Replace Replace
2) Brake system		
(1)Insufficient braking force	· Insufficient depressing of brake pedals · Improper pedal free play · Worn friction plates	Depress pedals positively Adjust Replace
(2)Brake noise	· Insufficient brake oil · Broken actuator spring · Eccentric wear of actuator	Replenish Replace Replace
(3)Brake overheating	· Insufficient oil · Excessive pedal free play · Improper operation	Replenish Adjust Operate brakes properly
(4)Brake cannot be disengaged completely.	· Improper brake pedal free play · Broken actuator spring · Broken pedal spring	Adjust Replace Replace
(5)Not uniform braking	· Improper free play adjustment · Worn actuator ball	Adjust Replace
(6)Excessive pedal play	· Improper adjustment of brake rod · Worn actuator-fork tightening bolt · Worn brake shaft or brake arm	Adjust Replace Replace

Chapter 8
Power assisted steering system

SECTION 1. GENERAL DESCRIPTION----------8-1

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2. Power Steering valve unit----------8-2
3. Oil tank----------8-2

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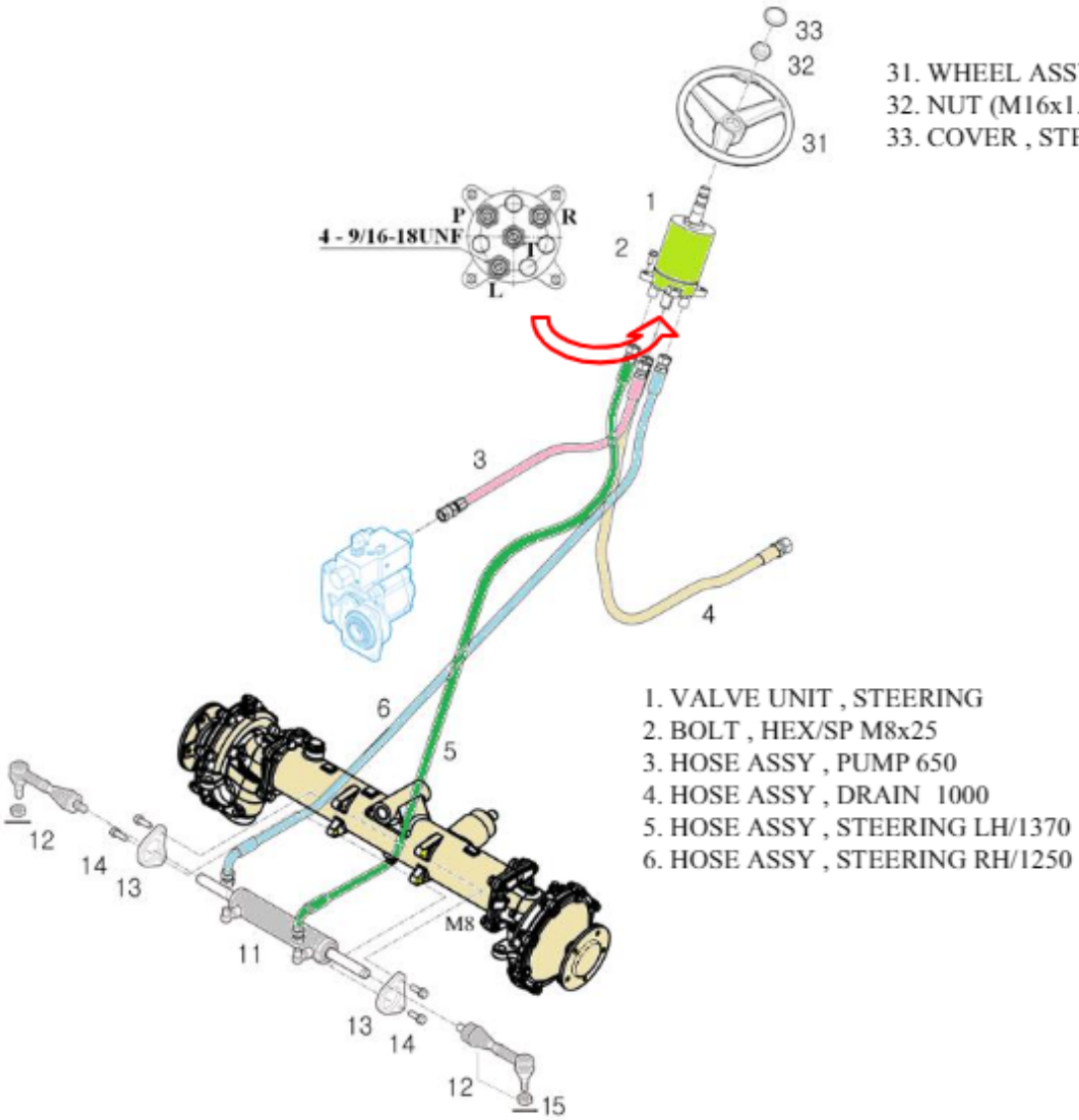
Chapter 8. Power assisted steering system.

SECTION 1. GENERAL DESCRIPTION

The hydraulics of this power-assisted steering system are actuated by a specially designed steering valve System. Non Load reaction valve blocks the L,R cylinder ports in neutral condition and does not transmits the reaction load of the tire to the steering wheel in neutral. Generally the system is used for the vehicles that treat heavy equipment or low speed traveling. Hydraulic circuit consists of independent system.
The oil from tank flows into gear pump for the steering valve via filter, and the quantity of oil in proportion to the rotations of steering wheel flows into steering Cylinder Via "R"-port at right turn and via "L"-port at left turn. As follow figure shows components composition of power steering system on the vehicle with the Steering valve.



31. WHEEL ASSY , STEERING
32. NUT (M16x1.5P)
33. COVER , STEERING

1. VALVE UNIT , STEERING
2. BOLT , HEX/SP M8x25
3. HOSE ASSY , PUMP 650
4. HOSE ASSY , DRAIN 1000
5. HOSE ASSY , STEERING LH/1370
6. HOSE ASSY , STEERING RH/1250

11. CYLINDER ASSY 12. JOINT ASSY, BALL (Ball joint/Nut, hex slot & castle(M12x1.25)
13. STAY, CYLINDER 14. BOLT , HEX /S M10x30 15. PIN , SPLIT 2.7X30

Fig.8-1

SECTION 2. SPECIFICATIONS

1. GEAR PUMP

MODEL		eMax S20 HST	
Delivery (cc/rev)		9	
Pump performance	100 (kgf/cm²)	1800 rpm	14.6 LPM
		2990 rpm	24.2 LPM
Rated pressure (kgf/cm²)		130	
Maximum pressure (kgf/cm²)		150	
Rated operation speed (rpm)		500~3000	
Rotation direction		C.W as viewed from shaft end	
Divider valve		8 LPM	For power steering valve
		15.8 LPM	For main control valve

2. Power steering valve Unit

MODEL	eMax S20 HST
Displacement (cc/rev)	45
Rated flow (ℓ/min)	16
Maximum system pressure (kgf/cm²)	125
Max. back pressure (kgf/cm²)	20
Max. temperature(°C)	95
Input torque (kgf.m)	0.14~0.18
Spline input torque (kgf.m)	1.2
Inlet relief pressure setting (kgf/cm²)	90 (at 8 ℓ/min)
Steering system type	Open Center Non-Load Reaction

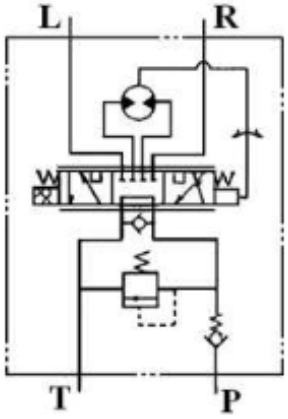
3. OIL TANK

MODEL	eMax S20 HST
TANK	TRANSMISSION
Fluid volume (ℓ)	14 Liter (3.7 gal)
Fluid	THF 500 (API GL-4 Grades) Gear oil #80 or #90

SECTION 3. FUNCTION (Reference)

SHINJIN is a hydrostatic steering unit which can be used with an add-on steering column, SHINJIN-T or with the steering column integrated with the unit.
The steering unit consists of a rotary valve and a rotary meter.
Via a steering column the steering unit is connected to the steering wheel of the vehicle.
When the steering wheel is turned, oil is directed from the steering system pump via the rotary valve and rotary meter to the cylinder ports L or R, depending on the direction of turn. The rotary meter meters the oil flow to the steering cylinder in proportion to the angular rotation of the steering wheel.
If the oil supply from the steering system pump fails or is too small, the steering unit is able to work as a manual steering pump.

SHINJIN-ON
Open center steering units have open connection between pump and tank in the neutral position.



1. TECHNICAL DATA (SINJIN)

All data should be written for reference.

Max. input flow			16 l/min [4.22 US gal/min]
Ambient temperature		Min.	–30°C [–22°F]
		Max.	+60°C [140°F]
Surface treatment	Permissible temperature assuming non-activated steering unit		120°C [248°F] for 20 minutes
Oil temperature		Min.	-30 °C [-27°F]
		Max.	+90 °C [194°F]
Oil viscosity		Min.	4 mm2/s [40 SUS]
		Max.	1000 mm2/s [4629 SUS]
Filtration	Max. degree of contamination ISO 4406	ON	22 / 20 / 17
		PB	22 / 20 / 17
Steering torque	Normal steering		0.8-1.5 Nm [7.08-13.3 lbf·in]
	Manual steering		Max. 80 Nm [708 lbf·in]
	Momentary load		Max. 160 Nm [1416 lbf·in]

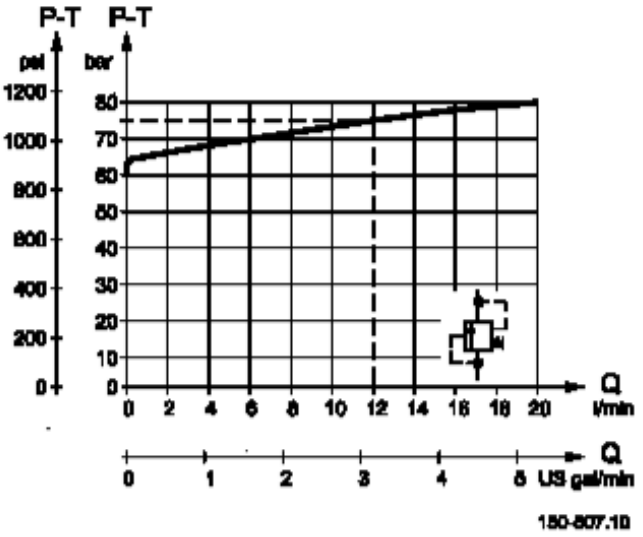
MANUAL STEERING PRESSURE

Under normal operating where the steering pumps supplies an adequate oil flow at the required pressure, the maximum torque on the steering wheel will not exceed 2 Nm[17.7 lbf·in]. If the oil flow from the steering system pump fails or is too small, the steering unit functions automatically as a manual steering pump. Manual steering can only be used for a limited control of the vehicle if a sudden drop of pump pressure occurs. The Pm 50bar[725 psi] shows the manual steering pressure (Pm) for all sizes of SHINJIN steering units type SHINJIN at a steering wheel torque of 80 Nm [708 lbf·in].The values apply only if the suction conditions on the steering unit T port are adequate.

PRESSURE RELIEF VALVE

The pressure relief valve protects the pump and steering unit against excess pressure and limits the system pressure while steering.

The pressure relief valve in the steering unit will limit the maximum pressure drop from P to T. The pressure relief valve is set at 10.5 l/min[2.8. US gal/min] flow.



SHOCK VALVES (Reference)

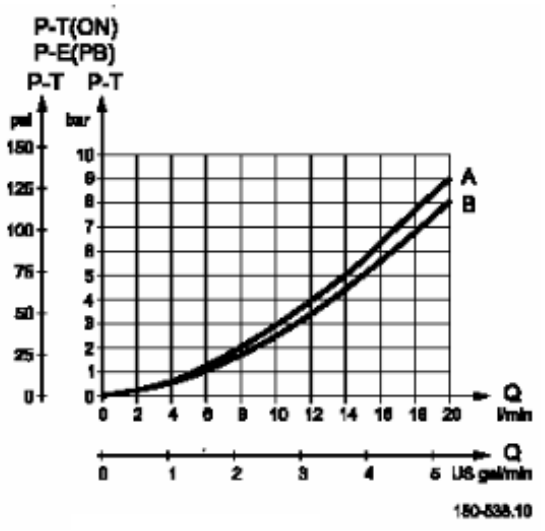
The shock valves protect the steering unit against shocks from external forces on the steering cylinder. The shock valves in the steering unit limit the max pressure drop from L to T and from R to T. The shock valves are set at 1 l/min [0.27 US gal/min]. They are of the direct type and therefore have a very quick reaction. The setting tolerance is +20 bar [+290 psi].

CHECK VALVE

The check valve protects the driver against kickbacks in the steering wheel. It prevents the oil from flowing back into the pump line during steering under high pressure on the cylinder side. The check valve is mounted in the P-connection of the steering unit.

PRESSURE DROP IN NEUTRAL

The pressure drop is measured with the steering unit in neutral position. On the SHINJIN ON the pressure drop is measured from P to T. The values are valid at an oil temperature of 50°C [122°F] and a viscosity of 21 cSt [100 SUS].



SECTION 4. Disassembly, Inspection, And Reassembly

1. Major component of steering valve (Reference)

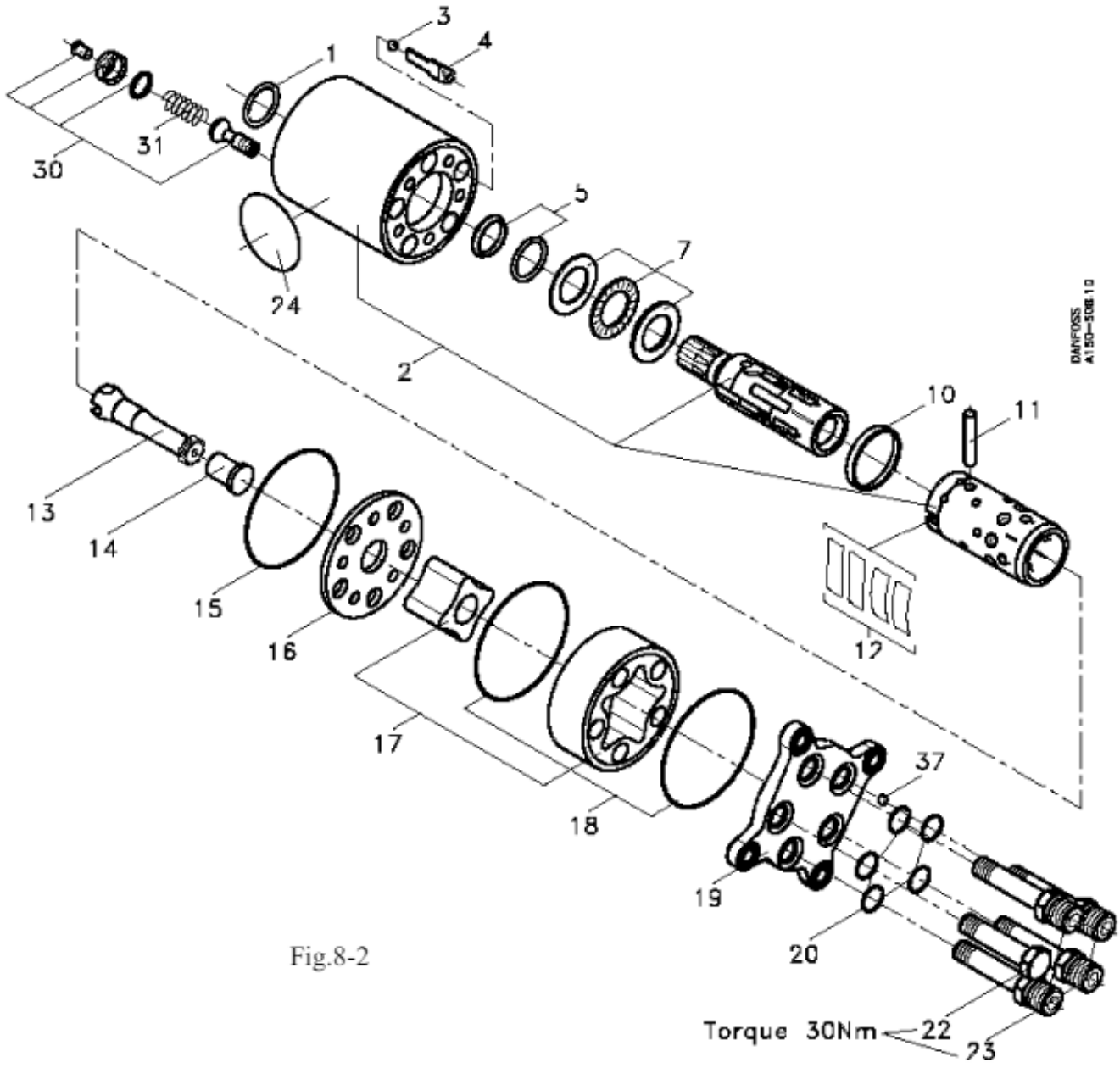


Fig.8-2

1.Dust seal ring 2. Housing spool and sleeve 3.Ball 4. Ball stop 5.Shaft seal 7.Bearing 10.Ring

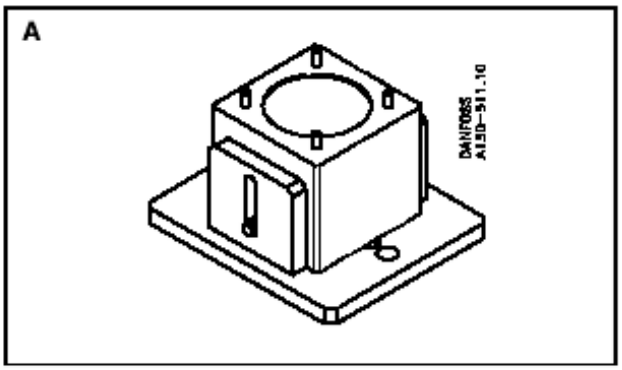
11. Cross pin 12.Set of springs 13.Cardan shaft 14.Spacer 15.O-ring 16. Distributor plate

17.Gear wheel set 18.O-ring 19.End cover 20.O-ring 22.Special screw 23. Special screw

24. Name plate 30.Complete relief valve.

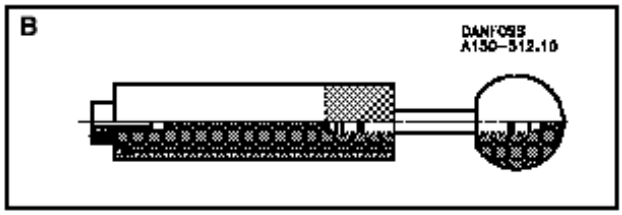
2.SPECIAL TOOLS

A.Holding tool, code no. SJ150L9001-01



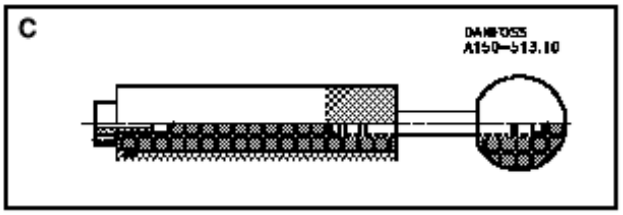
B . Assembly tool for shaft seal ø17.5,

code no. code no. SJ150L4011 - 01



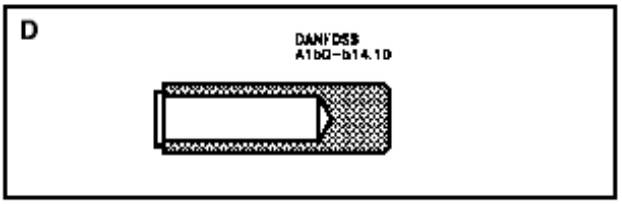
C. Assembly tool for shaft seal ø19,2,

code no. SJ150L4012 - 01



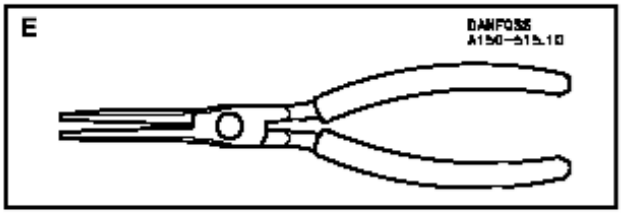
D . Assembly tool for dust seal ring,

code no. SJ150L0396 -01

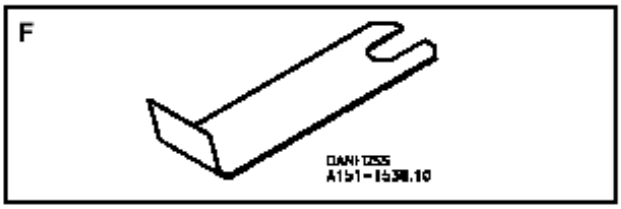


E. Pliers for piston in pressure relief valve,

code no. SJ150-9000 -25



F. Fork for fitting cardan shaft (OMM)
SJ 151G9000 -1



G . Ordinary hand tools.

Socket spanner (5/8 in)

Ratchet spanner, 1/2”

Torque wrench: 0-70 Nm (0-7 da Nm)

Allen keys: 5 & 8 mm a/flats

Small screwdriver, ground sharp.

Pincers

3. Disassembly

Separate the orbitrol referring to Fig.8-2 of SECTION .Disassembly,Inspection,And Reassembly 1.Major component of steering valve (orbitrol)

STEP 1.

- Column

If there is a steering column on OSPM, place the unit in the holding tool, on the **four locating pins** with steering column upwards. Dismantle the steering column.

STEP 2.

-Pressure relief valve (30, 31)

If there is a pressure relief valve in OSPM, remove the plastic plug from the adjusting screw and unscrew with the 5 mm a/flats Allen key. Remove the spring and use special pliers-lift the valve cone out of the housing.

Lift OPSM clear of the holding tool, turn it so that the output shaft points downwards and place it in the holding tool again.

Note, the locating pin in the tool must engage with the OSPM housing.

STEP 3.

-Special. Screws (22, 23)
Remove the screws with a 16 mm a/flats (5/8") spanner.

-End cover (19)
Remove end cover sideways.

STEP 4.
-Gear wheel set (17, 18)
Hold a hand under the gearwheel set to keep the gearwheel from falling out.
Remove O-rings.

STEP 5.
-Distributor plate (16)
Remove distributor plate.

-Cardan shaft (13)
Remove cardan shaft.

STEP 6.
-O-ring (15)
Remove O-ring from housing.

-Balls and ball stop (3, 4, 37)
Shake out check valve ball (not in all units), ball stop and emergency steering ball. Use pincers if necessary.

STEP 7.
Place the OSPM in the tool again. Lift up steering unit and fixture in one piece and turn it 90° to horizontal.

-Housing/spool/sleeve (2)
Turn the spool set so that the pin in spool and sleeve is horizontal and push it out

STEP 8.
-Bearing (7)
Remove bearing from shaft end.
The outer washer may sometimes adhere to the housing. If the washer does not come out with the shaft, it will come out when shaft seal item 5 is being pressed out.

-Ring(10)
Remove retaining ring for the neutral position springs.

STEP 9.
-Cross pin(11)
Press the pin out of the spool set.
Carefully press the spool out of the sleeve.

-Springs (12)
Press the neutral position springs out of the spool.

-Dust seal (1)
Remove the dust seal ring (with a "sharp" screwdriver).

-Shaft seal (5)
Remove the shaft seal
(with a "sharp" screwdriver if necessary).

4. Cleaning, inspection,replacement and lubrication

Note:
a.Clean all parts carefully.
b.Carefully check all parts and replace imperfect parts, if any.
c.Always replace all sealing parts during a repair.
d.Before assembly, lubricate all parts with hydraulic oil and grease rubber parts with vaseline.

5.REASSEMBLY

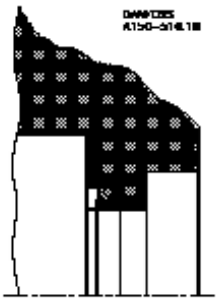
STEP 1.
-Housing (2)
Place the OSPM housing horizontally in the holding tool, with the hole for the output shaft facing the tool.

Note: the locating pin in the tool must engage with in the OSPM housing.

STEP 2.
-Shaft seal (5)

With the assembly tool the shaft seal must into the housing.
Note that the small guide piece at the front of the tool must remain in the hole for the output shaft when the tool itself is drawn out of the housing.

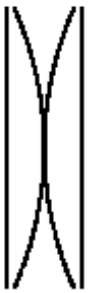
Note: there are two different tools:
One for housings for steering column mounting (SJ150L4011-01)
One for housings with integrated steering column (SJ150L4012-01).



STEP 3
-Spool/sleeve (2)
Guide spool and sleeve together, turn the spools so that the key slots are opposite each other.

STEP 4.
-Springs (12)

Insert the curved springs between the flat springs and push them into place (see sketch).



STEP 5.

Spring retaining ring (10)

Center the springs in the spool/sleeve set and guide the ring down over the sleeve.

Note:
The ring must be able to rotate unimpeded by the springs.

STEP 6

-Cross pin (11)
Fit the cross pin in the spool set.

-Thrust bearing (7)
Fit the thick race, needle cage and thin race.Lubricate the output shaft on the inner spool with Molykote PG plastslip 75,on the surface in contact with the shaft seal.

STEP 7
-Housing /spool/sleeve (2)

a.With the housing still horizontal in the holding tool - secure it with one hand. With the other hand take the assembled spool/sleeve set, making sure two fingers hold the cross pin (11) in position. Guide the spool set into the housing with the cross pin (11) horizontal.

Note:
Be careful with the small guide piece from mounting of the shaft seal.
With it is pressed out by the shaft rotary.

b. With housing and spool set remaining in the tool,lift the whole unit into vertical position. The pin in the spool set must now point towards port P in the housing, either at 6 o'clock or 12 o'clock.

STEP 8.

-Ball (3)
Place the emergency steering ball in port P.

-Ball stop (4)
Place the ball stop in port P.

-Ball (37)
Place the check valve ball (if required) in port P

STEP 9.

-O-ring (15)
Fit the O-ring in the housing.

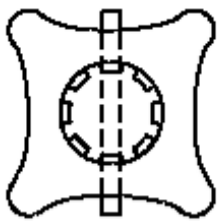
-Distributor plate (16)
Place the distributor plate on the housing.
Turn it so that the holes line up.

STEP 10
-Cardan shaft(13)
Fit the cardan shaft into the inner spool and allow it to engage with the pin.

If so required use fork SJ 151G9000-1to retain the cardan shaft.

STEP 11
17 Gear wheel
When fitting the gearwheel, it must be oriented correctly so that it engages with the cardan shaft.

The cross pin (11) in the spool set must line up with the bottom of the teeth in the star
(see sketch).



STEP 12
-O-rings (18)
Place the O-rings in the grooves on each side of the gearwheel rim.

-Gear ring (17)
Place the gearwheel rim over the distributor plate so that all holes are in line with each other.

STEP 13.
-Spacer (14)
Place the spacer over the cardan shaft.

-End cover (19)
Place the cover so that the hole marked "P" lines up with port P in the housing("6 o'clock " or "12 o'clock").

STEP 14.
-Special screws (20, 22,23)
Fit screws (with O-rings). Remove the retainer fork. Tighten all five screws (cross pattern) with 30 ± 3 Nm (3 da Nm).

Note:
With open center units, the screw with no oil flow connection must be fitted in port E.

If the OSPM must be mounted with a Pressure relief valve, lift it out of the tool and place it on the four pins with the axle journals upwards.

STEP 15.
-Piston (30)
Fit the piston.
-Spring (31)
Fit the spring.

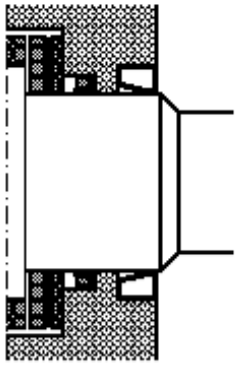
STEP 16.
-Adjustment (30)
Screw in the adjusting screw.

STEP 17. (Test)

a.Lift OSPM out of the tool and prepare it for testing.
The pressure relief valve can be set either on a test panel or in a system with pressure-gauge read-off.
b.Insert plastic plug.

STEP 18.
Dust seal (1)
Guide the dust seal ring down over the shaft end press into place in the housing with assembly tool. SJ 150L0396 - 01.

Note: The dust seal must be fitted after testing so that any leakage from the shaft seal can be detected.



SECTION 5. TROUBLESHOOTING

Problems and probable causes	Counter measures
1. Steering wheel is very heavy to turn	
1) Poor assemble between steering column and unit.	
(1)Spline of column and unit are assembled tightly.	-Replace column spline
(2)Spool of unit is seized by spline of column.	-Check column assembly face and spline length (MAX 6.5㎜)
(3)Poor rotation of column	-Replenish oil or Exchange
2) Insufficient pump pressure or fluid volume	
(1)Check pump delivery (Unit volume×120 rpm×1.15)	-Exchange pump
(2)Check oil tank fluid volume	-Replenish oil
(3)Check pump pressure	-Adjust relief pressure
3)Trouble internal steering unit valve	
(1)Low setting pressure of relief valve	-Adjust fluid level properly
(2)Ball-nut heavy to work	-Wash clean or replace
4)Trouble machine mechanism.	
(1)Poor link work	-Wash and replenish oil
(2)Excessive sector gear pre-load	-Adjust backlash
2. Return to neutral is too slow	
1) Poor assemble steering column and unit	
(1)Poor assemble to center between column and unit	-Loosen the bolt and fix again with center
(2)Column assembly face depressed unit bushing	-Replace column or repair
2) Depressed control set (spool+sleeve)	
(1)Excessive fluid volume	
(2)Excessive pressure	-Adjust fluid level properly
(3)Dust	-Adjust pressure -Wash
3) High pressure ratio of "T" port (tank port)	
(1) Tank port hall is small	-MAX. Pressure ratio 20 bar
(2) Tank port pipe is linked to other lines	-Wash and clean pipe line -Separate unit pipe line and reinstall

Problems and probable causes	Counter measures
3. Free play of steering wheel	
1)Too low elastic of centering spring (Remove P port pipe line and check left and right turning) (1)Damaged spring or poor elastic	-Replace spring
2) Depressed control set (1) Excessive fluid and pressure (2) Depressed by foreign material (3) Depressed from external when assemble with column	 -Adjust fluid level and pressure properly -Wash -Check column and adjust
4. Steering wheel resistance with turning	
(1)Worn of spline gear column (2)Depressed control set (3)Air trapped in cylinder and pipe line (4)Excessive backlash column (5)Poor turning of column,or wear of bearing .	-Replace column -Wash,and Adjust fluid level and pressure properly -Deflate the air -Adjust column -Replace column and replenish oil
5.Too much free play of steering wheel(Rough touching on tire causes vibration)	
(1)Air trapped in steering cylinder and pipe line. (2)Worn ball bearing	-Deflate the air -Replace
6.Free play steering wheel	
(1)Insufficient oil in the tank (2)Worn,damage steering cylinder (3)Loose spacer in unit	-Replenish oil -Replace oil seal and cylinder -assemble spacer parts.
7.Kick-back of steering wheel	
(1)Loose check valve in "P" port or don't operate (2) Trouble in system	-Adjust check valve -consult workshop

Problems and probable causes	Counter measures

8. Serious kick-back each side

(1)Poor assemble the gyrotor lower the unit	-Reassemble

9. Steering wheel is very heavy to begin turning

(1)Oil density is too high or cool	-Replace oil

10. External Oil leakage

(1)column (2)End cap gyrotor (3)Tightening Bolt	-Replace oil seal, slide ring -Replace o-ring -Replace copper washer (Torque 1st:175 kgf·cm. 2nd:280 kgf·cm)

SECTION 1. GENERAL DESCRIPTION---------- 9-1

SECTION 2. SPECIFICATIONS---------- 9-2

SECTION 3. MAJOR COMPONENT OF THE HYDRAULIC SYSTEM ---------- 9-3

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2. Divider valve and PTO solenoid valve ---------- 9-4
3. Flow-control valve(Slow-return check valve)---------- 9-6
4. Relief valve---------- 9-6
5. Gear pump ---------- 9-7
6. Strainer Suction---------- 9-8

SECTION 4. HYDRAULIC SYSTEM ---------- 9-9

SECTION 5. TROUBLESHOOTING ---------- 9-12

Chapter 9 Hydraulic system

SECTION 1. GENERAL DESCRIPTION

The hydraulic system is composed of a gear pump, valves, oil filter, cylinder (actuator), piping, etc.

The implement lift is operated by a control valve which is actuated by the control lever through a link mechanism.

ON and OFF of the PTO is controlled by a hydraulic, wet multi-disc clutch whose circuit is opened and closed by an electromagnetic valve in the flow-divider.

The construction and circuit of the hydraulic system are shown in Fig.9-1.

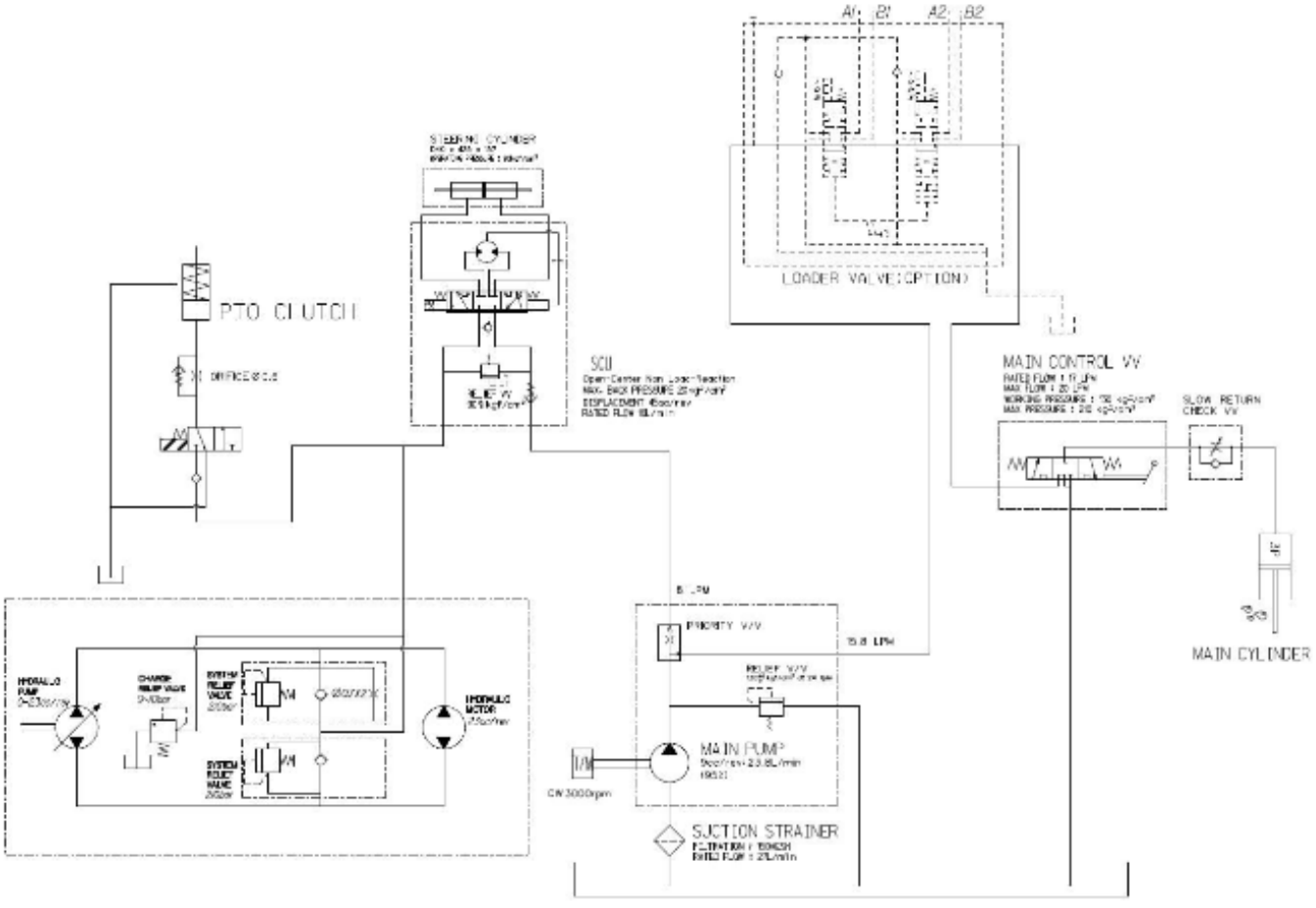


Fig.9-1 hydraulic system construction

SECTION 2. SPECIFICATIONS

Model		eMax S20 HST
Piston And cylinder	Hitch lift capacity, (kg) At lower link top end / 24 inches behind link arms	600 / 480
Control Valve	Cylinder port leaks (cc/min) (under a pressure of 9800kpa(100 kgf/㎠) With gear oil SAE 80W	10
Main relief Valve	Maximum pressure (kgf/㎠)	150
	Relief pressure (kgf/㎠)	130
Gear Pump	Delivery(94~96% efficiency) : Liter at 3000rpm (Engine)	23.8
Suction Filter	Rated flow (ℓ/min)	27
	Filtration density (mesh)	120 ~150
	Filtration area (㎠)	82 ㎠

SECTION 3. MAJOR COMPONENT OF THE HYDRAULIC SYSTEM

1.HYDRAULIC SYSTEM

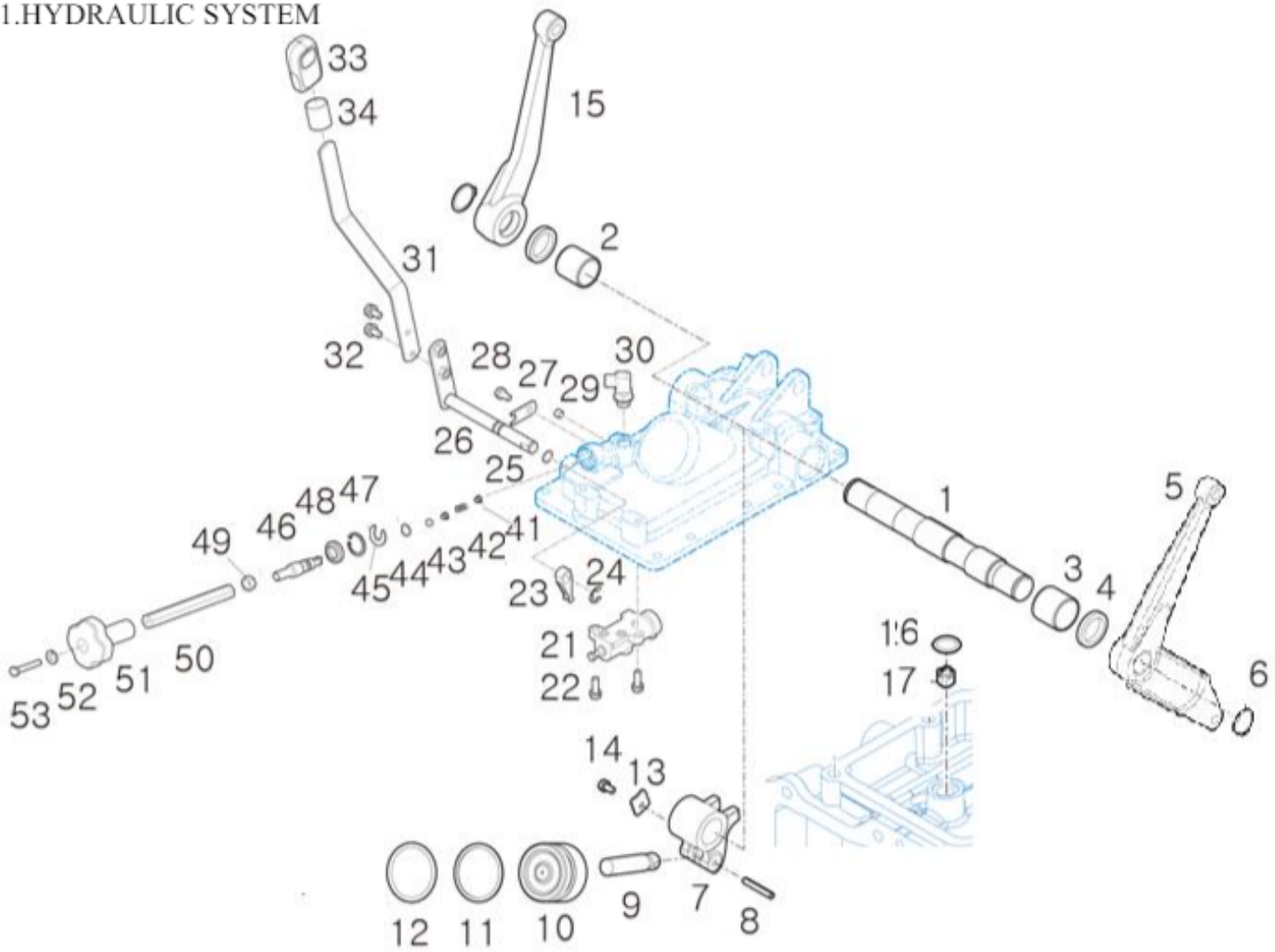


Fig.9-2

1. SHAFT , LIFT
2. BUSH , 35X42X40
3. BUSH , 40X46X40
4. SEAL , OIL/D35488
5. ARM , LIFT (LH)
6. C-RING , SHAFT
7. CRANK , LIFT
8. PIN , SPRING (8X50)
9. ROD , PISTON
10. PISTON , HYD
11. RING
12. O-RING , P70
13. PLATE
14. BOLT , HEX/S (M8X16)
15. ARM , LIFT (LH)
16. O-ring
17. POPPET
21. VALVE , CONTROL
22. BOLT , HEX/S (M8X25)
23. FORK , VALVE
24. E-RING
25. O-RING , P12
26. LEVER COMP , POSITION
27. PLATE
28. BOLT , HEX/S (M8X16)
29. PLUG , HEX-SOCKET TAPER R1/8
30. ELBOW(PF3/8 , PF3/8)
31. LEVER , POSITION
32. BOLT , HEX/SP (M8X25)
33. KNOB , POSITION
34. TUBE
41. GUIDE , SPRING
42. SPRING , 17
43. BALL , STEEL (D=7.5)
44. O-RING , P10
45. PLATE , STOPPER
46. VALVE , SLOW RETURN
47. C-RING , HOLE 25
48. SEAL , DUST 15
49. NUT , HEX/2 (M10)
50. SHAFT , SLOW RETURN
51. KNOB , SLOW RETURN
52. WASHER , SPRING (M6)
53. SCREW , C/R PAN (M6X40)

2. DIVIDER VALVE AND PTO SOLENOID VALVE

GENERAL DESCRIPTION

Gear pump body is installed to bypass working fluid of a specified pressure constantly from the main circuit into the main control valve and power steering valve through a priority valve. Gear pump has a function to be a zero pressure in the power steering line with a optional valve. It is operated when the engine is started.

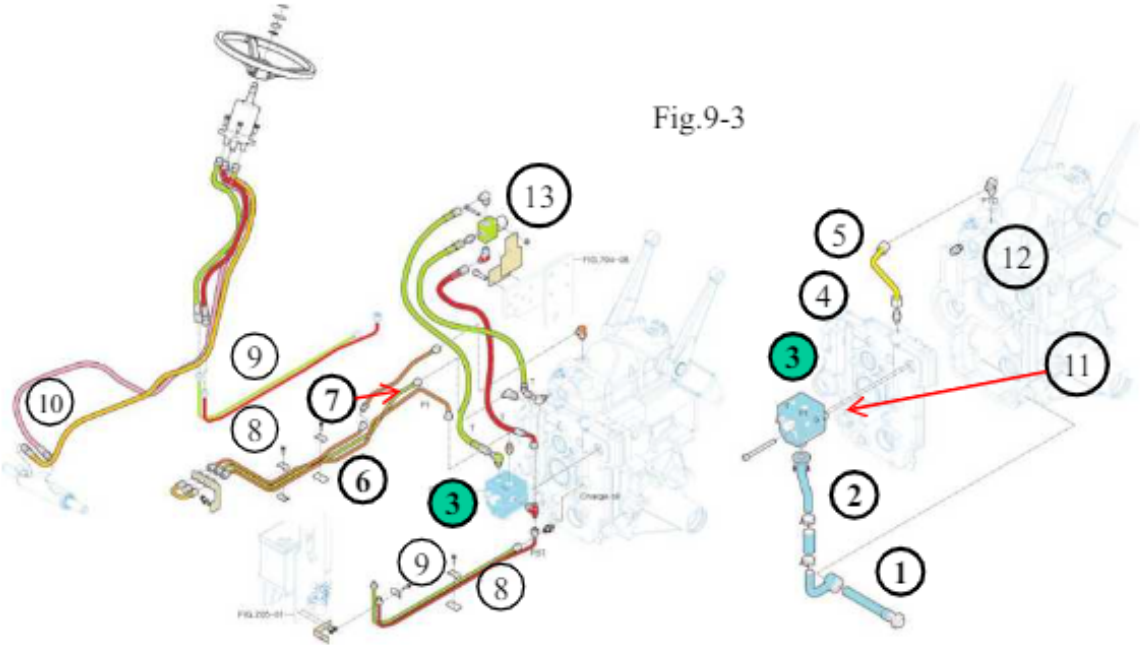


Fig.9-3

1. Hydraulic oil filter 2. Suction pipe 3. Gear pump
4. Input metal 5. PTO pipe 6. Delivery pipe
7. Drain pipe 8.Steering valve pipe 9. Charge pipe
10. Power steering pipe(LH, RH) 11. Relief valve in the gear pump
12. PTO solenoid valve 13. Optional valve (Unload)

1) Gear pump body and optional valve(Unloading)

This valve in the gear pump body regulates to be distributed the main control valve and power steering valve as specified fluid displacement. The principle of distribution is that the fluid is controlled by check valve in the gear pump body.

And optional valve has a solenoid valve in the block. When the ignition switch is turned, the direction of the fluid flow is changed with optional valve in order to make zero pressure automatically.

And the fluid flow is changed to make the pressure in the steering system after the engine has been started

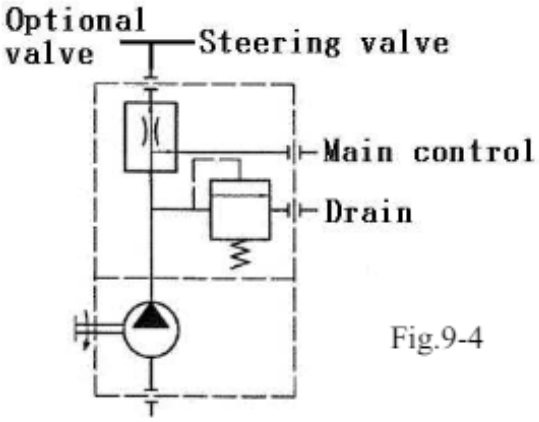


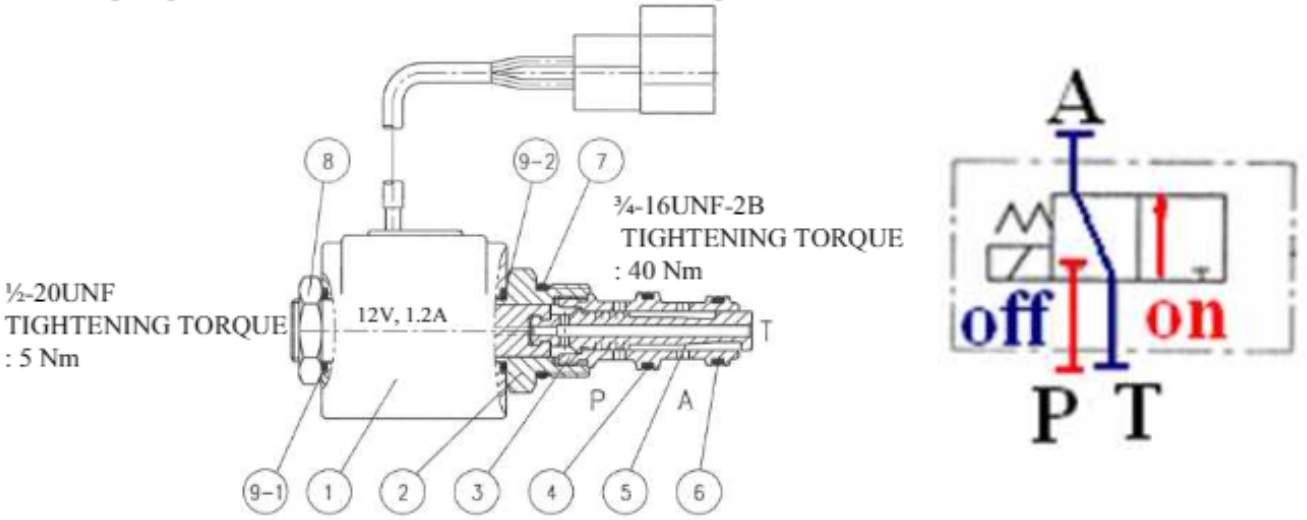
Fig.9-4

2) PTO Solenoid valve

This solenoid is switched on or off by operating the PTO switch. The oil pressure flows from the back pressure of the power steering valve.

When the PTO solenoid is switched 「ON」, 「OFF」

The fluid from the steering valve flows to port P. The pressure of the PTO clutch circuit is the same with the relief valve in the hydrostatic unit. The specified pressure is set at charge relief valve constantly as shown in the diagram. When PTO solenoid is switched "ON", the fluid flows to PTO clutch. When PTO solenoid is switched "OFF", the port A is blocked and the entirety of fluid flows to the charge relief valve. The force imposed upon the left-hand side of the valve is from P to A plus electrical power, consequently the spool is pushed leftwards. whereas the force imposed upon the right-hand side of the valve is from A to T plus the spring force. Here, so the fluid from the steering valve is branched off to the PTO clutch.



1. COIL ASS'Y 2. CARTRIDGE ASS'Y 3. SLEEVE 4. O-RING A14 5. SPOOL
6. O-RING A13 7. O-RING B8 8. LOCK NUT 9. O-RING B15

Fig. 9-5 PTO solenoid switch 「ON」,「OFF」 position

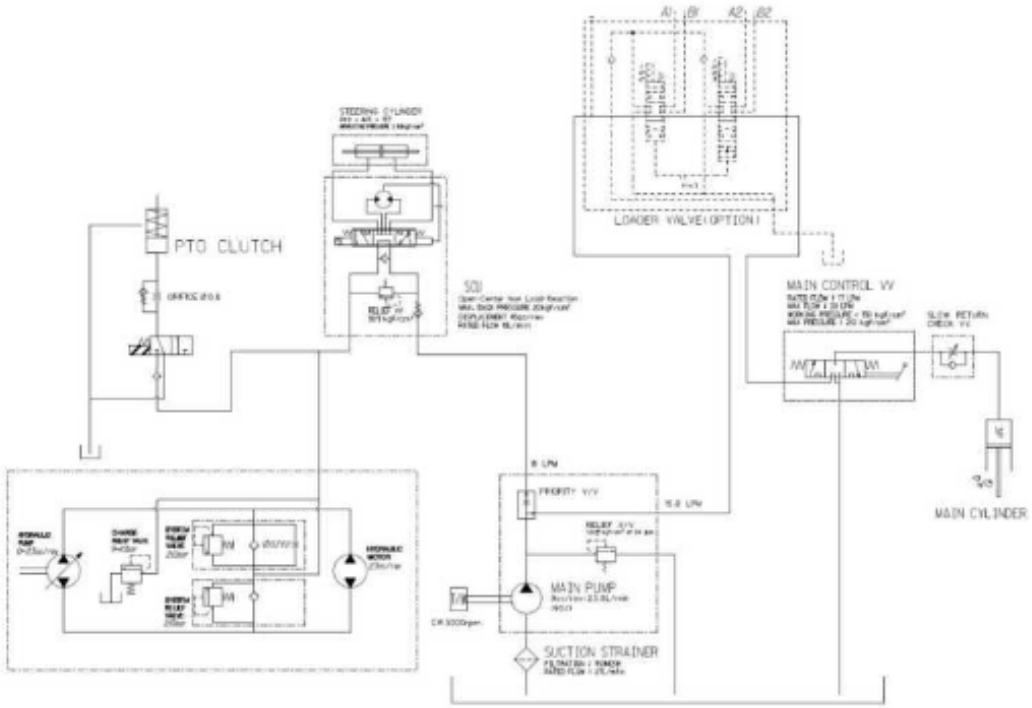


Fig.9-6

3.FLOW-CONTROL VALVE(SLOW-RETURN CHECK VALVE)

1) GENERAL DESCRIPTION

This valve regulates the lowering speed of the lift by controlling the unloading flow from the lift cylinder to the tank.

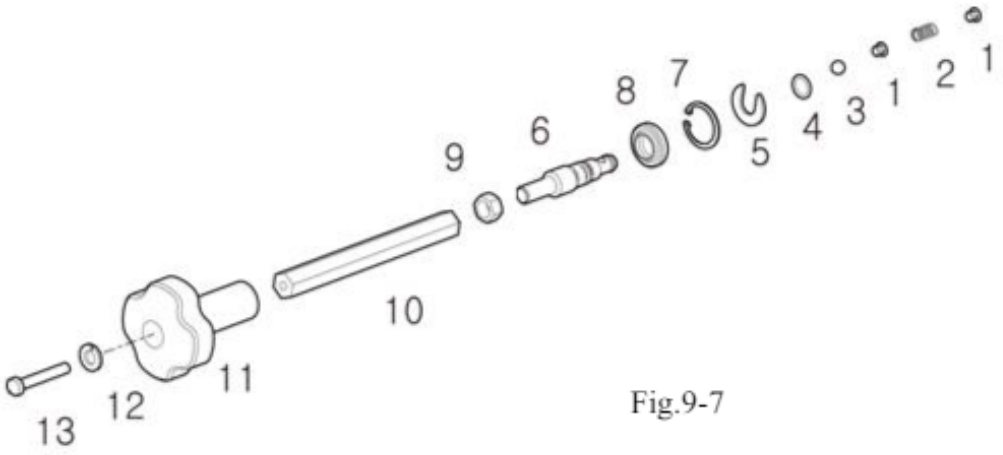


Fig.9-7

1. GUIDE , SPRING 2. SPRING , 17 3. BALL , STEEL (D=7.5) 4. O-RING , P10
5. PLATE , STOPPER 6. VALVE , SLOW RETURN 7. C-RING , HOLE 25 8. SEAL , DUST 15
9. NUT , HEX/2 (M10) 10. SHAFT , SLOW RETURN 11. KNOB , SLOW RETURN 12. WASHER , SPRING (M6)
13. SCREW , C/R PAN (M6X40)

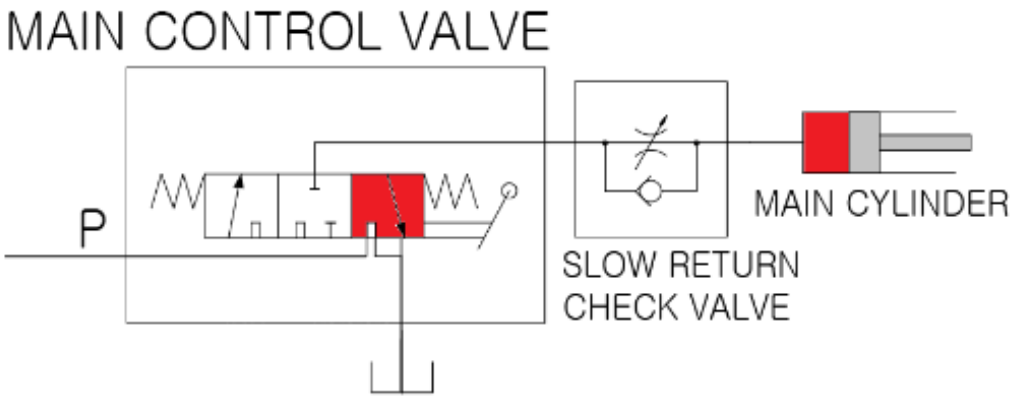


Fig. 9-8 Slow-return check valve Diagram

4. RELIEF VALVE

1) GENERAL DESCRIPTION

This valve regulates the maximum pressure in the whole hydraulic circuit. The regulated pressure can be set with the adjust screw. This valve is installed into the gear pump block.

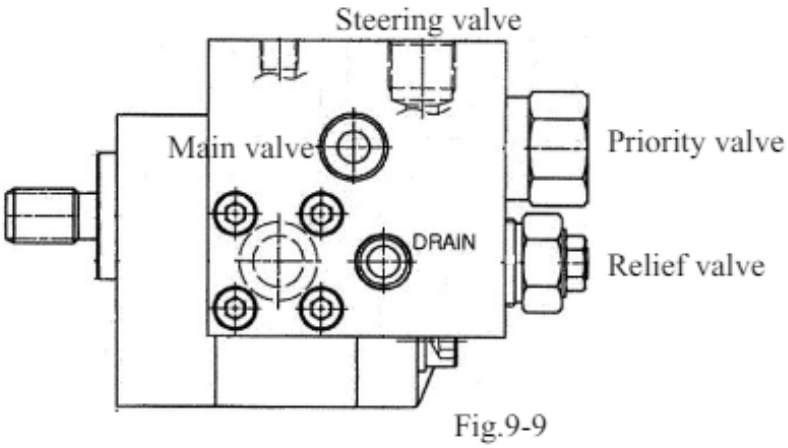
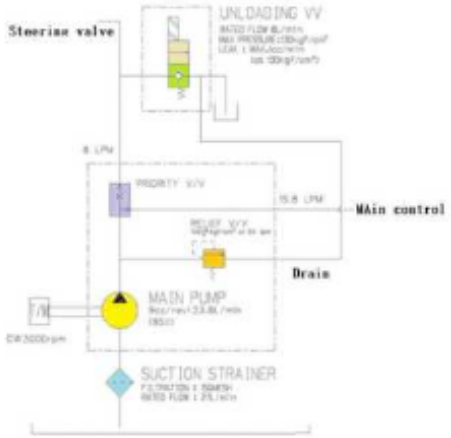


Fig.9-9



2) MEASUREMENT OF THE RELIEF PRESSURE

The engine should be shut down in advance.

Remove the elbow. Install the elbow with screw (PF1/4).

Install a compression gauge to measure the pressure (Over 200 kgf/cm^2).

Turn the ignition switch to start engine and wait for 5 minutes to warm up.

PF1/4

Fig.9-10

Measurement the Pressure must be done 3 times and should be set within specified pressure.

Specified relief pressure	130 kgf·㎠ (Main Hydraulic)
	9kgf·㎠ (Steering Hydraulic)

5. GEAR PUMP

1) GENERAL DESCRIPTION

This pump induces fluid from one side and delivers it to the power steering valve and main control valve through gear pump body by rotating the PTO gears meshed. The actual delivery is as mentioned below, considering the consequences of fluid temperature and volume efficiency in accordance with revolution speed. That is single pump system.

2) Gear pump

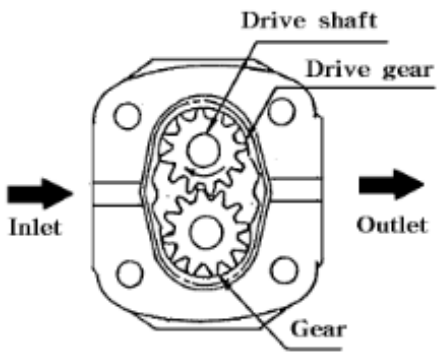


Fig.9-11

3) MEASUREMENT OF THE PUMP

The best way to measure for the pump is to use a special tester.

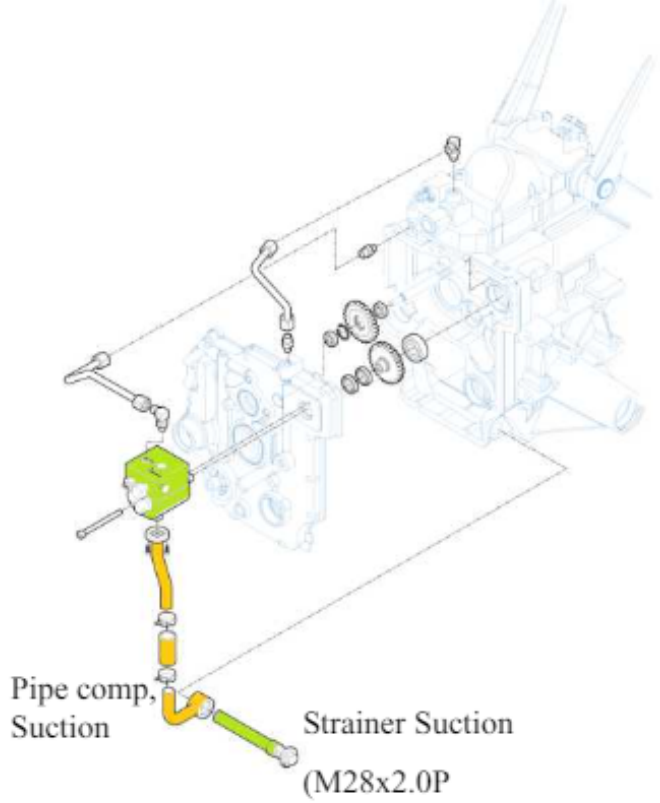
But if it's not available, use installed tractor.

Remove the plug in the divider valve.

Install a compression gauge to measure the pressure.

It is possible to test the hydraulic pressure by referring the before page.

6. Strainer Suction



1) GENERAL DESCRIPTION

The tractor is equipped with the hydraulic filter.

2) SPECIFICATIONS

Applicable oil	GEAR OIL SAE 80W-90
Rated flow rate(ℓ/min.)	27
Filtration density (mesh)	120~150 mesh
Filtration area	82 ㎠
Working oil temperature (℃)	-20 ~100℃

3) REPLACEMENT

Check the surface to be matched for damage or scratch and replace defective ones.

When installing the strainer, be sure to install the strainer body properly with grease applied.

SECTION 4. HYDRAULIC SYSTEM

Note : Hydraulic system must be washed clean, and care must be taken to prevent any foreign substances.

The O-ring and back-up ring should be coated with grease ahead of time.

Install them with care so as not to damage them and install the O-ring and Back-up ring with correct assembly sequence.

1) Install the bush (LH, RH) after applying the grease to the case and outer bush by special tool.
And the slit of bush should be installed towards the front side as shown in Fig 9-14.

2) Install the Piston in the cylinder case after applying grease to the O-ring and Back-up ring.

Note : Pay attention to the correct sequence.

3) Assemble the piston rod and the lift crank with the spring pin.

Note : Pay attention to the correct direction to install the spring.

4) Insert the crank shaft in the hole of case and insert the piston rod in the cylinder.
Install the lift crank to crank shaft by reference to their matching marks.
The lift crank and piston rod should be assembled ahead of time.

Note : Be careful not to damage the Bush.

5) Install the seal (LH, RH) and install the lift arms by reference to their matching marks.

6) When installing the control valve, apply grease to the O-rings and avoid their dislocation or binding during tightening the valve to the specified torque 180 ~200kgf-㎝

7) Insert the piston control lever in the case after installing the O-ring.

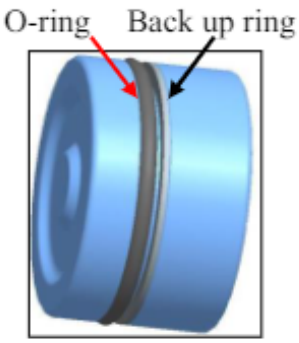
Note : Apply grease to the O-ring in advance.

8) Install the fork to piston control lever after installing the fork in the groove of spool of control valve.
And install the snap ring. Make sure the snap ring should be securely seated in the groove and to the correct direction.

9) Install the plate to fix the piston control lever.

Note : Check the spool should be operated smoothly by the piston control lever.

10) Install the slow return valve to the specified torque.



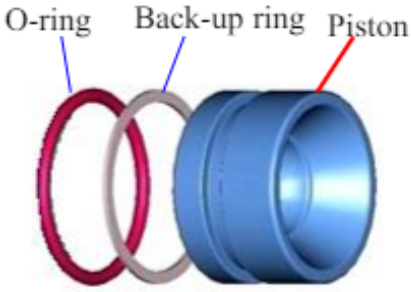


Fig.9-13

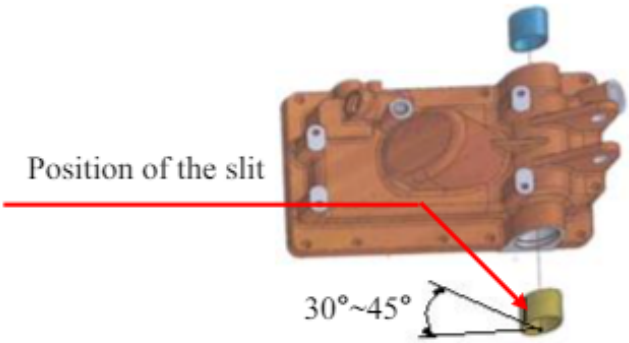


Fig. 9-14 Direction of the bush

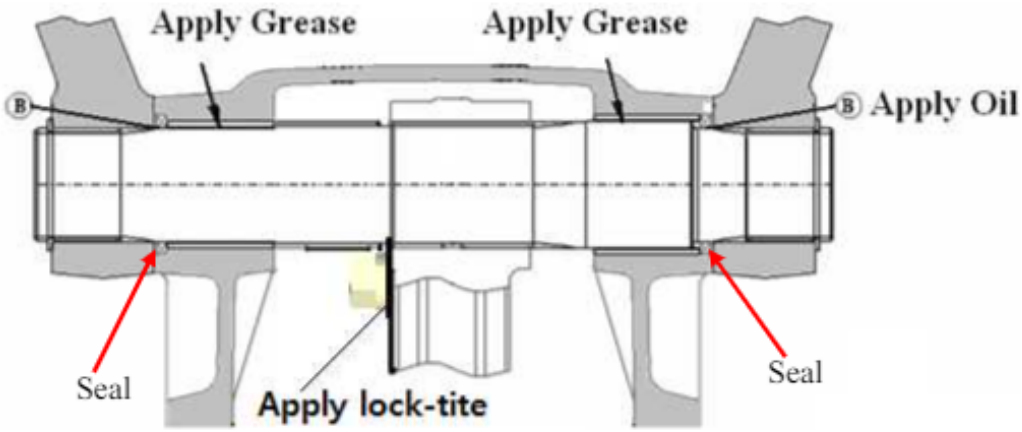


Fig.9-15.Lift arm

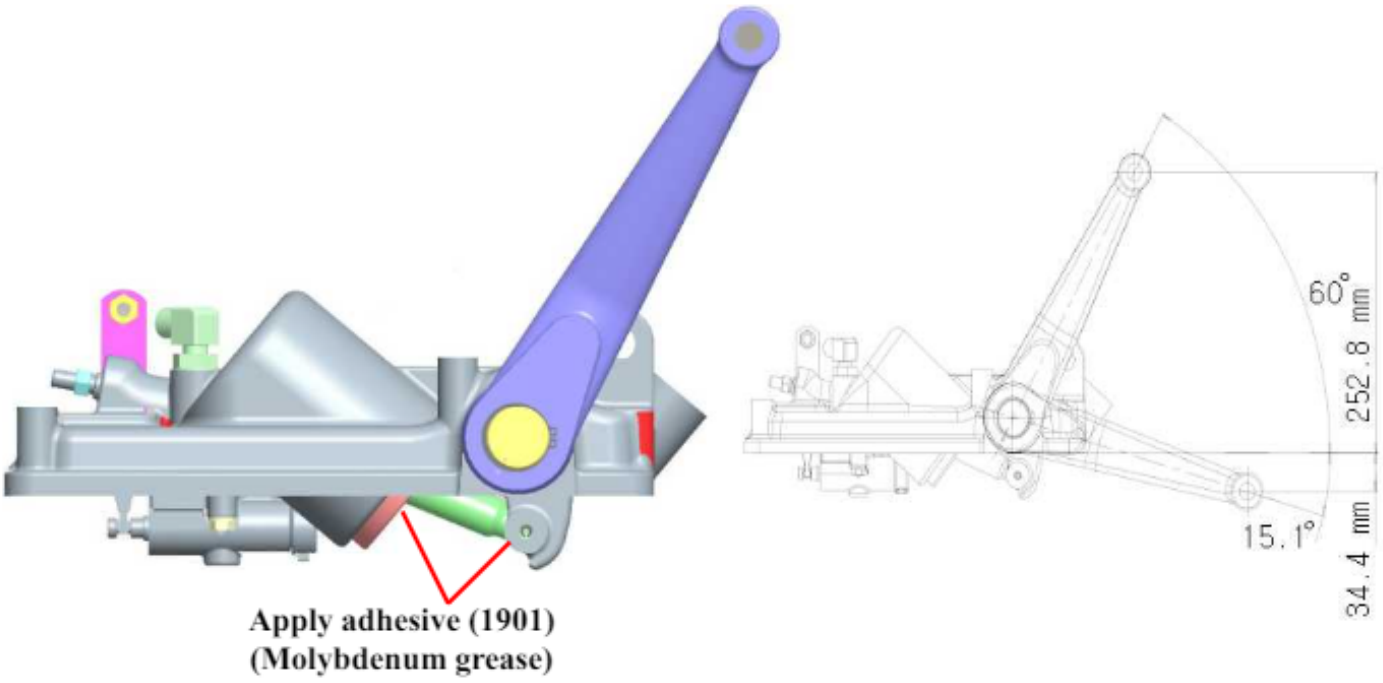
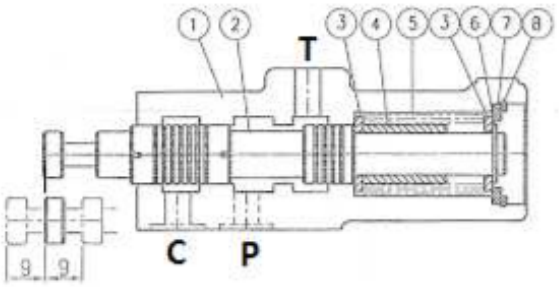


Fig.9-16. Hydraulic cylinder.

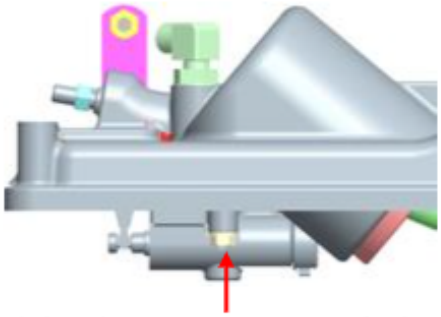
Note : Be sure not to over operate within specified spool stroke
(9mm between up and down at neutral position)



Rise ⇔ Descent

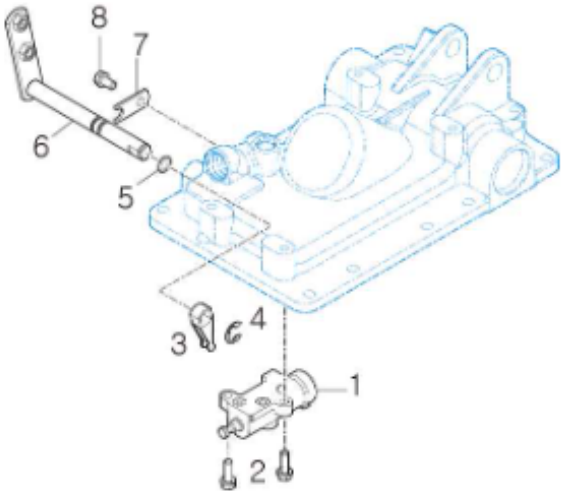
Fig.9-17

1. Body 2. Spool 3. Spring Retainer 4. Spacer 5. Spring
6. Snap ring (E 7) 7. Washer 8. Snap ring (C24) 9. O-ring (P10



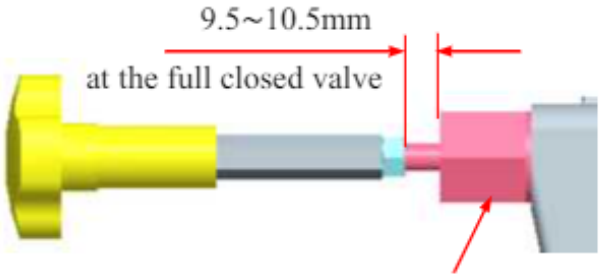
Tightening torque : 1.8~2.0kgf-m

Fig.9-18



1. VALVE , CONTROL
2. BOLT , HEX/S (M8X25)
3. FORK , VALVE
4. E-RING
5. O-RING , P12
6. LEVER COMP , POSITION
7. PLATE
8. BOLT , HEX/S (M8X16)

Fig.9-19



Tightening torque : 10~12kgf-m

Apply oil

Fig.9-20

Problems	Causes	Countermeasures
1.Lift does not rise	1) Insufficient engine speed	Raise engine speed slightly
	2) Insufficient transmission oil	Maintain oil level by replenishing with the same kind of oil
	3) Air taken in through suction	Tighten securely or replace broken parts.
	4) Clogged suction filter	Clean.
	5) Broken or poor hydraulic pump	Inspection pump and repair or replace if necessary.Pay particular attention to shaft seal because a broken seal sometimes intakes air.
	6) Poor link mechanism	Inspect,adjust,repair,or replace if necessary.(Refer to section 3)
	7) Excessive load on lift	Decrease load
	8) Broken cylinder	Replace
	9) Too low viscosity of transmission oil	As it will cause oil leaks or internal wear,replace with gear oil of SAE80
	10)Maladjusted relief valve	Readjust. (Cracking:refer to the specifications)
	11)Excessive internal leaks	Inspect cylinder and valves.Replace damaged seals,and repair. (Check each part systematically)
	12)Broken flow divider (Stuck sequential valve spool)	Disassemble and wash spool clean. If it is damaged seriously,replace it as an assembly.If damage is minor,correct surface with oil stone and finish by lapping.
	13)Broken control valve (Even when spool is shifted to up position,lift does not rise)	
	①Stuck compensator plunger (unloading valve 1)	Lap after repairing flaws with oil stone
	②Clogged orifices or slanted orifices in pilot passage.	Clean them with compressed air or a sharp point.
	③Stuck poppet(unloading valve 2)	Correct minor flaws with oil stone
	④Bitten or stuck check valve plunger	Lap after repairing flaws with oil stone
	14)Broken slow-return check valve	
	①Stuck poppet	Lap after disassembling, cleaning, and repairing flaws with oil stone

Problems	Causes	Countermeasures
2.Too low rising speed of lift	1)Above causes can also be possible	Repair according to above instructions.
	2) Too small a spool stroke in control valve	Inspect,readjust,or replace link mechanism if necessary.
	3)Broken compensator spring (unloading valve 1) in control valve	Replace spring.
	4)Stuck poppet (unloading valve 2)	Correct minor flaws with an oil stone
3.Lift lowers even when adjust knob is closed fully with adjust Handle (While engine is stopped)	1)Stuck poppet	Lap after disassembling,cleaning,repairing flaws with oil stone
	2)Poor valve seat	Replace valve
	3)Poor 0-ring	Replace
4.Lift does not lower	1)Slow-return-check valve knob is turned to the lock position	Turn knob to fast position
	2)Stuck poppet of slow-Return-check valve	Lap after disassembling, cleaning,repairing flaws with oil stone
	3)Seized lift shaft	Apply grease and repair or replace bushings or shaft if necessary.
	4)Stuck main spool	Lap lightly after disassembling, cleaning, and repairing flaws with oil stone or replace as an assembly.
5.Too slow lift lowering speed	1)Above mentioned causes can also be possible.	Repair or adjust according to instructions mentioned above.
	2)Insufficiently lowered control lever	Lower lever sufficiently
	3)Excessively closed slow-return check valve	Open valve sufficiently
6.When hydraulic control lever is raised,relief,valve beeps.	1) Maladjusted lever stopper check valve	Readjust lever stopper guide position
	2) Poor link mechanism	Inspect,readjust,repair,or replace link mechanism if necessary.
7.Fluid overheating	1)Excessively high working pressure	Inspect and adjust
	2)Too high or low viscosity of working fluid.	Replace with fluid of adequate viscosity.
	3)Insufficient fluid	Maintain specified level by replenishing

Problems	Causes	Countermeasures
8.Pump noise	1) Partially clogged suction filter or suction piping.	Clean.
	2) Air inhaled through suction piping and intake pipe connections for pump	Inspect and retighten.
	3) Loosened pump cover tightening bolts.	Inspect and retighten
	4) Too rich oil viscosity	Replace with fluid of adequate viscosity.
	5) Broken or worn pump parts	Inspect and replace defective parts.
9.Excessive wear,deflection or damage of pump	1) Dirty fluid	Eliminate foreign matter and inspect filters.
	2) Circuit pressure exceeds pump capacity	Adjust relief valve or replace if necessary
	3) Oil-less operation due to Insufficient oil quantity	Inspect transmission oil level and maintain specified oil level by replenishing. In either case, clean, and repair pump parts and replace damaged ones if necessary.
10.Oil leaks outside pump	Broken or fatigues oil seal or O-ring	Replace
11.Oil leaks from piping or joints	Poorly connected piping	Inspect,clean,and eliminate dust. Repair flaws with oil stone if necessary. Retighten.
	Poor O-ring	Replace
	Broken piping	Replace with a new one after washing clean related parts.
12.Oil leaks around lift arm	Poor oil seals	Replace oil seal or bushing if necessary
13.Independent PTO clutch slips or is too slow in engaging	1) Clogged fixed orifice of Flow divider	Disassemble and wash clean.
	2) Port B regulated pressure is too slow	Inspect and reset pressure
	3) Clogged PTO pressure control valve or stuck	Disassemble and wash clean. Repair flaws with oil stone if necessary or replace with a new one.
	4) Poor flow divider solenoid valve	Disassemble and repair or replace with new one if necessary .

Problems	Causes	Countermeasures
14.Independent PTO clutch is too quick in engaging	1) Stuck pressure-reducing valve spool	Lap after correcting flaws with oil stone
	2) Fatigued or broken pressure-reducing valve spring	Replace.
	3) Worn or broken sealing of PTO clutch	Replace
	4) Worn friction plates or driven plates	Replace
	5) Overheated fluid	Refer to paragraph for "fluid overheating"
	6) Port B regulated pressure is too high of Flow-divider	Inspect and reset pressure
	7) Stuck pressure-reducing valve spool	Lap after correcting flaws with oil stone
	8) Clogged orifice in pressure-reducing valve spool	Clear clogged with compressed air or with a sharp point.

Chapter 10 Electrical accessory and instruments

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Chapter 10 Electrical accessory and instruments

SECTION 1. GENERAL DESCRIPTION

The basic electrical system of tractors consists of the engine cranking system, battery charging system, lighting system, meters, switches, etc.
For further information concerning the engine cranking equipment and battery charging equipment, please refer to the engine manual.
The battery is a power source to activate the engine cranking system, lighting system and other electrical equipment. The lighting system is used to activate the illumination lights, indicators, and signal lights. The meter is a device that enables the operator to be aware of the present operating conditions; oil pressure gauge, water temperature gauge(thermometer), fuel gauge, etc. are installed.
All the controls, meters, and indicators are arranged around the operator's seat for easy Maneuverability readability, and convenience.

SECTION 2. SPECIFICATIONS

MODEL			E$ MAX 22 / 25 HST	
PART NAME			Specification(w)	Quantity
1.lighting system	Head lights		55/55	2
	Rear combination lights	Turn signal lights	21	2
		Stop lights	21	2
		Tail light	5	2
2. Monitoring system	Meter assembly	Hour meter	-	1
		Fuel gauge	-	1
		Thermometer	-	1
		Tachometer	-	1
		Pilot light	(3.4)	13
	Horn		-	-
3.Fuses	Fuses(A)	In main fuse box	5A	3
		(with spare fuse)	10A	1
	Slow blow fuse	Fuse Charge	50A	1
		Fuse Sol.	60A	1
		Fuse Main	40A	1
4.Battery			12V51Ah	1
5.Alternater			12V40A	1

SECTION 3. BATTERY

1.INSPECTION

1.1 INSPECTION OF ELECTROLYTE LEVEL

As the battery repeats charging and discharging during operation.The water content in the electrolyte gradually evaporates, and as a result,the level should be inspected at the specific level;replenish with distilled water.

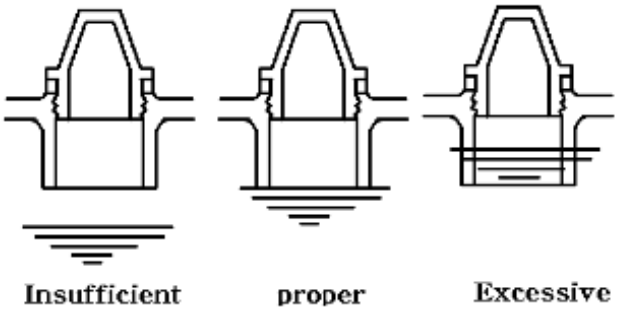


Fig.10-1 electrolyte level

1.2 INSPECTION OF ELECTROLYTE SPECIFIC GRAVITY

The specific gravity of the electrolyte lowers as the battery discharges,so the battery condition can be determined by measuring the specific gravity.The specific gravity can be measured generally with a suction type hydrometer which must be read properly as shown in Fig. 10-2

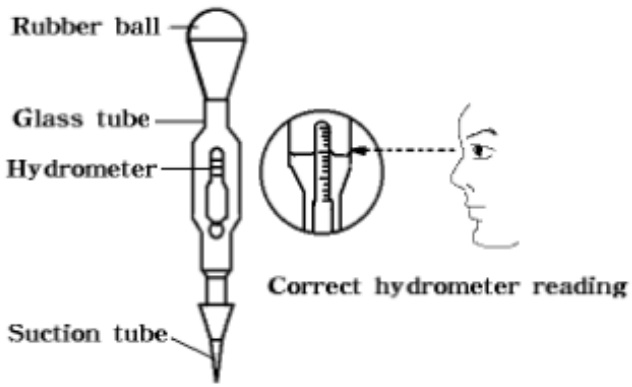


Fig.10-2 electrolyte gravity

Note:

When the distilled water is added,charge the battery to mix it well into the electrolyte before measuring the specific gravity.

a.Temperature correction of the hydrometer reading

The specific gravity of the battery electrolyte(diluted sulfuric acid) varies with the temperature of the electrolyte at a rate 0.0007 specific gravity point for each 1℃ change in temperature.Therefore, when the specific gravity of the electrolyte in the battery is measured with a suction type hydrometer,a temperature correction should be made,using the following formula to permit the direct comparison of the measured valve with the standard specific gravity at 20 ℃.

S_{20} :St+0.0007(t-20)

S_{20} :Specific gravity at standard temperature of 20 ℃.

t : Temperature of the electrolyte at the time of measurement

St : Specific gravity of the electrolyte measured at t ℃.

1.3 BATTERY CHARGING

If the specified gravity of the battery electrolyte in lower than 1.220 (at 20 ℃),the battery should be recharged,because leaving an undercharged battery without recharging it will lead to permanent battery damage.The battery is subject to self-discharge at a rate as shown in the table below.Therefore it should be recharged from time to time when storing the battery unused for a long period of time.

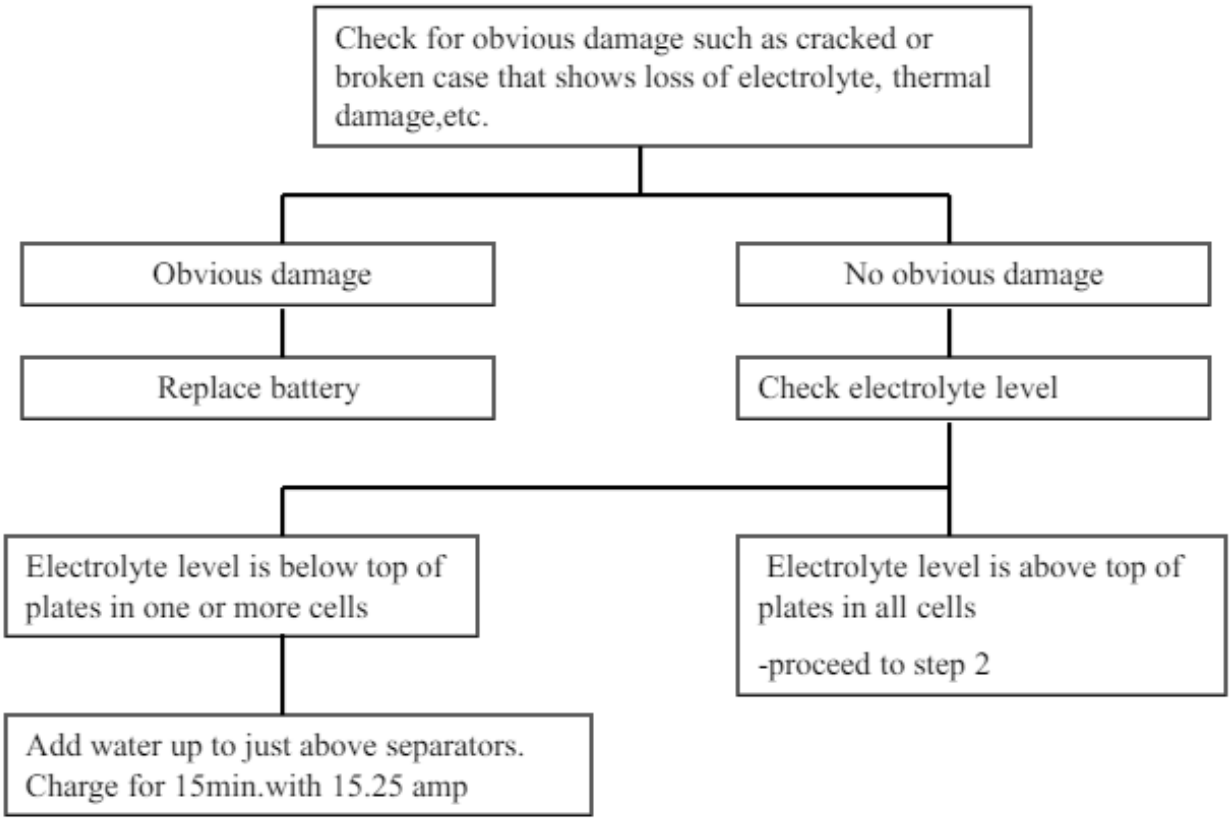
When recharging the battery,wash clean the outside of the battery case and the battery posts.Check the level of the electrolyte in each cell and replenish with distilled water as necessary.

Temperature	Self-discharge rate per day (%)	Decrease in specific gravity per day
30 ℃	1	0.002
20 ℃	0.15	0.001
5 ℃	0.025	0.005

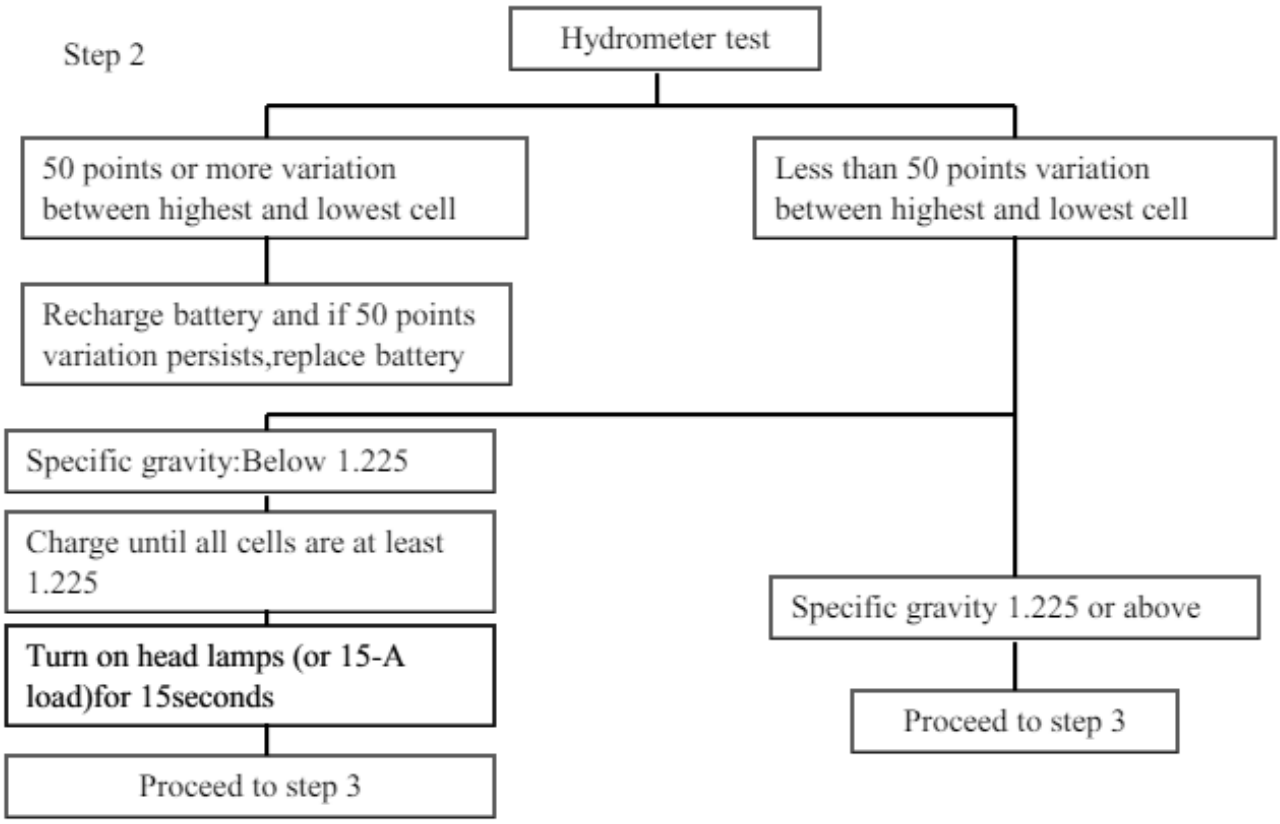
1.4 BATTERY TESTING CHARTS

Step 1.

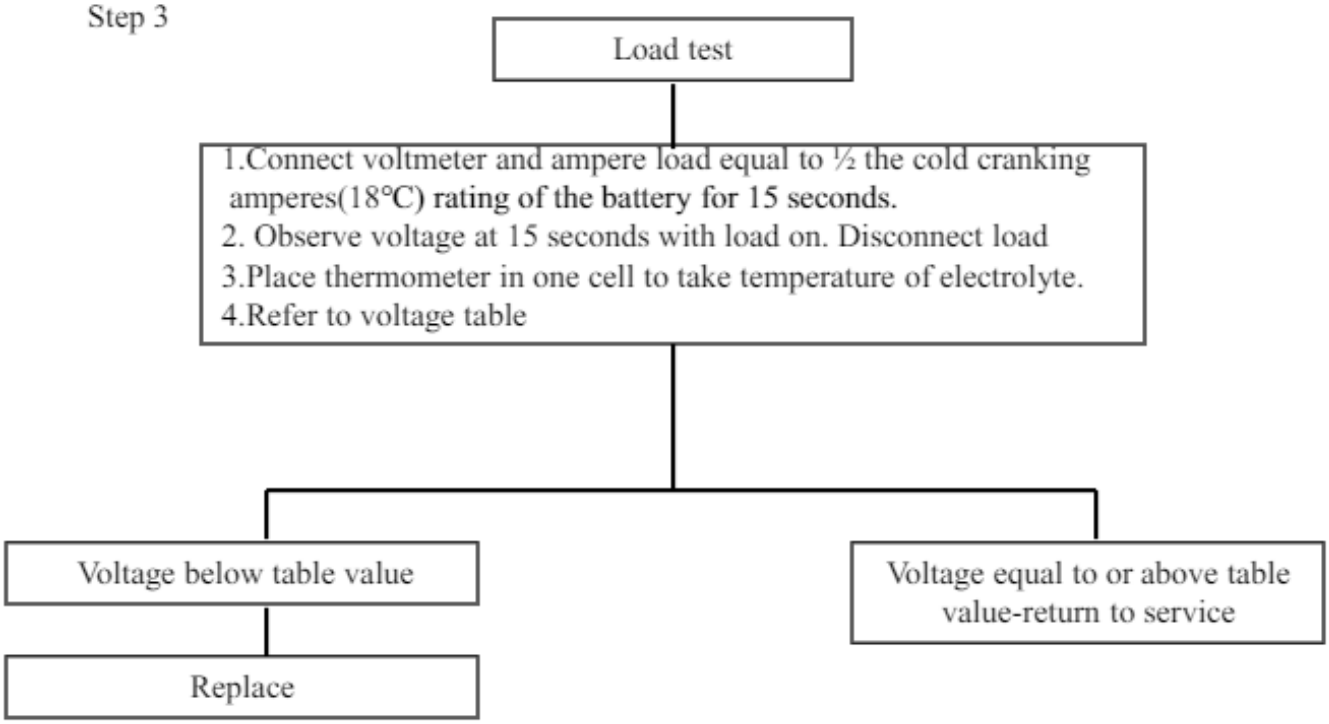
VISUAL INSPECTION


Check for obvious damage such as cracked or broken case that shows loss of electrolyte, thermal damage,etc.
Obvious damage
No obvious damage
Replace battery
Check electrolyte level
Electrolyte level is below top of plates in one or more cells
Electrolyte level is above top of plates in all cells
-proceed to step 2
Add water up to just above separators. Charge for 15min.with 15.25 amp

Step 2


Hydrometer test
50 points or more variation between highest and lowest cell
Less than 50 points variation between highest and lowest cell
Recharge battery and if 50 points variation persists,replace battery
Specific gravity:Below 1.225
Charge until all cells are at least 1.225
Turn on head lamps (or 15-A load)for 15seconds
Proceed to step 3
Specific gravity 1.225 or above
Proceed to step 3

Step 3


Load test
1.Connect voltmeter and ampere load equal to ½ the cold cranking amperes(18℃) rating of the battery for 15 seconds.
2. Observe voltage at 15 seconds with load on. Disconnect load
3.Place thermometer in one cell to take temperature of electrolyte.
4.Refer to voltage table
Voltage below table value
Replace
Voltage equal to or above table value-return to service

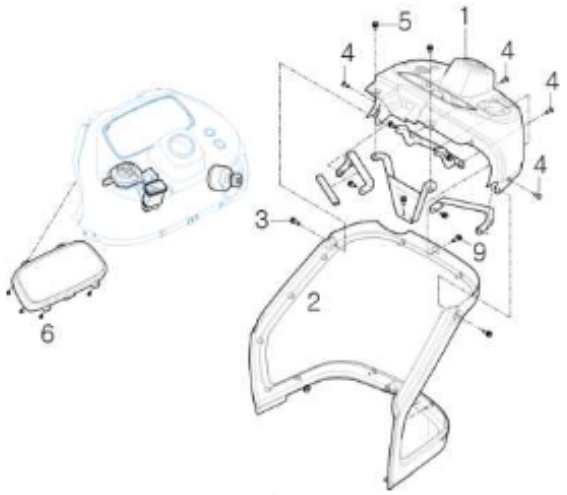
Voltage table	
Estimated electrolyte temperature	Minimum required voltage under 15 sec.load (Use ½ these values for 6-V batteries)
70 °F (21 °C) and above	9.6
60 °F (16 °C)	9.5
50 °F (10 °C)	9.4
40 °F (4 °C)	9.3
30 °F (-1 °C)	9.1
20 °F (-7 °C)	8.9
10 °F (-12 °C)	8.7
0 °F (-18 °C)	8.3

SECTION 4. METERS AND SWITCHES

1. METERS

1.1 Removal

a. Remove the Dash cover(2).
b. Disconnect the negative cable from battery.
c. Remove the dash cover, upper (1).
d. Remove the bolts(6) which hold the meter panel and lift up the panel assembly by removing the wire harness couplings..



1.COVER COMP , UPR/DASH 2.COVER COMP, LOW/DASH
3.BOLT , HEX /SP M6x20 4.SCREW , C/R FLAT
5.BOLT , HEX /SP M6x16 6.SCREW , TAPPING (M4x16)

Fig.10-3 Meter panel

1.2 Tacho/hour meter

a. Construction

An electric tachometer is employed along with a tachosensor. The tach/hour meter converts engine revolutions to electric signals, which is sent to the tachometer. The tachometer displays the engine revolutions visually. The tachosensor generates 10 pulses per one engine revolution. The generated pulses are converted into voltage output through a converter. Then the voltage is divided into three different phase coils through a IC circuit. The tachometer pointer is swung by the compound magnetic field generated by the three point.

b. Inspection

-Tachometer
The allowable error of a tachometer reading is specified as shown on the table below.
If the reading deviates from the specified value. Replace the meter assembly.

Engine speed(rpm)	1000 (200Hz)	2000 (400Hz)	3000 (600Hz)
Allowable error(rpm)	±150		

1.3 Fuel gauge.

a. Construction

When the fuel tank is full, the float is at the top and has moved the variable resister to a position of least resistance. This feeds maximum current into the meter circuit and the pointer swings fully to the F position. Consequently when the fuel level in the tank is low, everything acts in reverse.

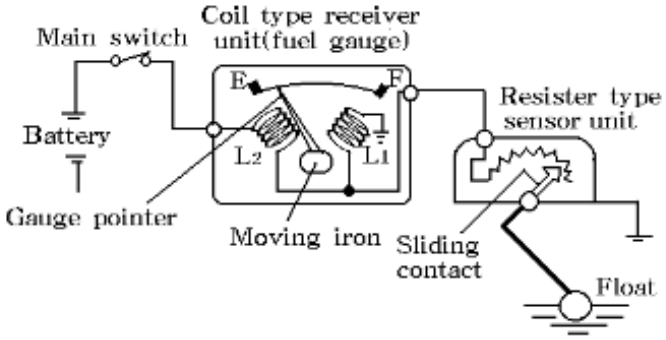


Fig.10-5 Fuel gauge

b. Inspection

-Fuel meter

Connect the fuel gauge to form a circuit with the resisters as shown Fig.10-6 and check to see if the gauge pointer swings to each position: F. 1/2 and E by changing the resistance value.
If it does not change the gauge assembly.

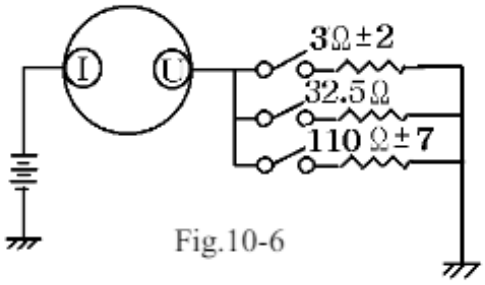


Fig.10-6

-Fuel gauge sensor(variable resistor)

Check each resistance value with a tester at each float position as shown in Fig.10-7.if the measured values are deviated from respective specified values,replace the sensor assembly.

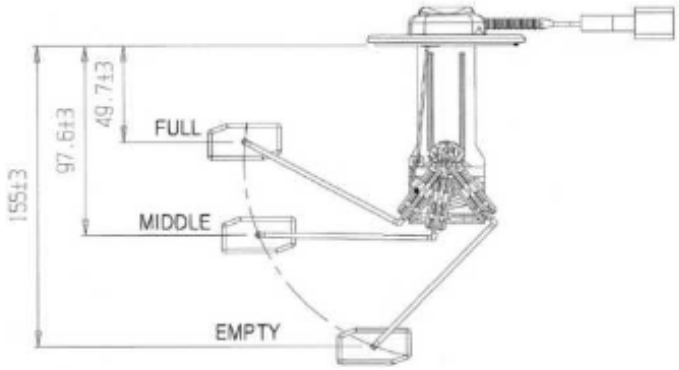


Fig.10-7

Standard pointer position	F	(1/2)	E
Regulated resistance(Ω)	3	(32.5)	110
Allowable error(Ω)	±2		±2

1.4. Thermometer

a. Construction

This is the same moving magnet type meters as the fuel gauge. As the coolant temperature becomes higher, the resistance in the thermo unit(sensor) become lower, which results in more current to the meter circuit and swinging the meter pointer to the high temperature side on the scale. Of course, as the coolant temperature become lower, everything acts in reverse.

b. Inspection

Normally the thermometer resisters higher values as the coolant temperature rises after the engine is running. If it does not, check the wiring first. If the wiring is normal. Replace assembly.

2. STARTER SWITCH

(1) Removal

a. Remove the dash cover (2).
b. Remove the ring nut holding the starter switch using a conventional screw driver.
c. Pull out the key switch as shown in Fig.10-8

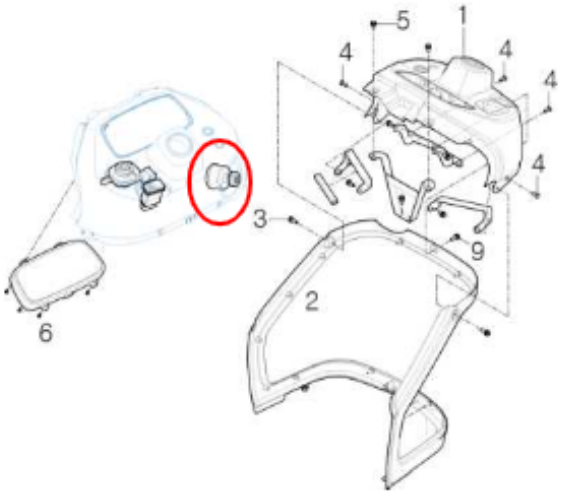


Fig.10-8

(2) Inspection

a. The main switch circuit, switching positions, and terminals are as shown in the figures. Check the continuity across respective terminals referring to the switch circuit diagram. Replace a defective switch as an assembly.

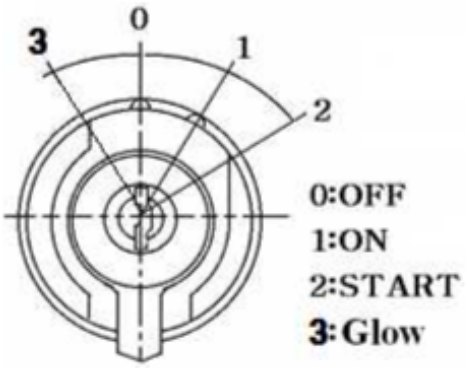


Fig.10-9

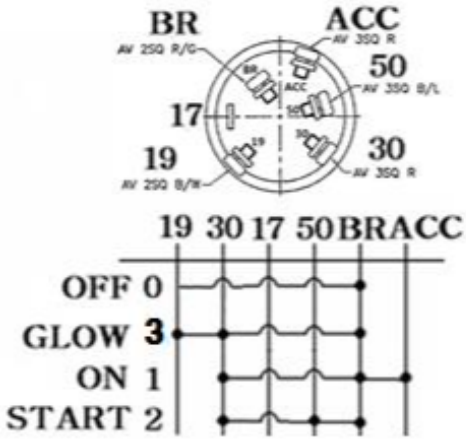


Fig.10-10

3. COMBINATION SWITCH

1) Removal

(1) Remove the dash cover(Lower).

(2) Remove the combination switch.

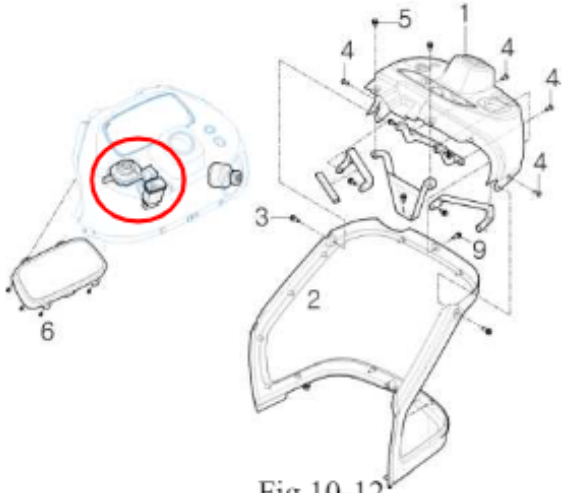


Fig.10-12

2) Inspection

Each switch circuit is as shown, so check each switch for a continuity across respective terminals with a tester. Replace a defective switch as an assembly.

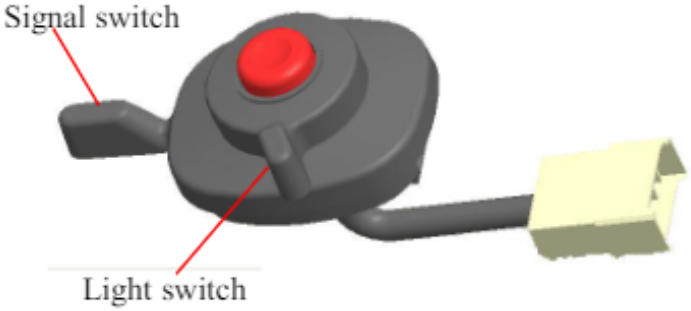
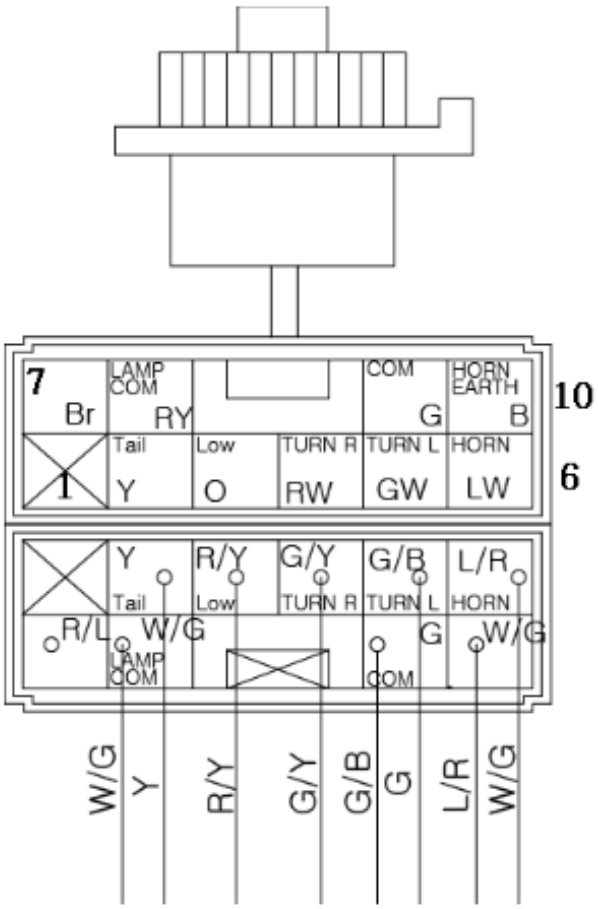


Fig.10-13 combination switch



1. NC 2. Tail lamp 3. Low beam 4. Turn (R)
5. Turn (L) 6. Horn 7. NC 8. Lamp COM
9. COM 10. Horn earth

Fig.10-14 Harness socket

-Lighting

Color code	R (Red)	RY (Red /Yellow)	Y (Yellow)
	8 : B1*1	2 : T	3 : 1
OFF **2			
1	●	●	●

*1 :Terminals

**2: Switching positions

-Flasher

Color code	GW (Green/ White)	RL (Red/ Green)	G (Green)
	9: B2*1	4 : R	5: L
1**2	●	●	
OFF			
2	●		●

*1 :Terminals

**2: Switching positions

	9	4	5
⇨	○	○	
OFF			
⇦	○		○

-Horn switch (Reference)

Color code	B (Black)	LW(Light/White)
	7 : B1*1	1 : H
Free**2		
Push	●	●

*1 :Terminals

**2: Switching positions

	7	1
FREE		
PUSH	○	○

4. STOP LIGHT SWITCH

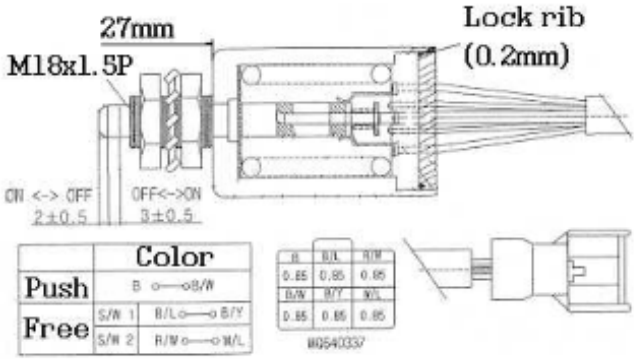


Fig.10-15 Stop light switch

Capacity	10~20A (DC12V)
Stroke to ON	2 ±0.5mm
Total stroke	5mm

5.RELAY UNIT

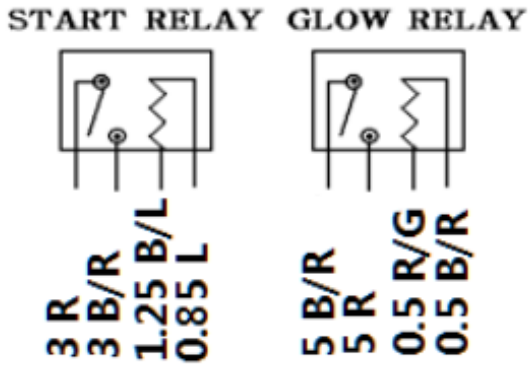


Fig.10-16 Relay unit

6. FUSE

Fuses are installed in the main fuse box.
Three fusible links are installed to protect the wiring from burning due to a short circuit.
Each fuse is connected as follows

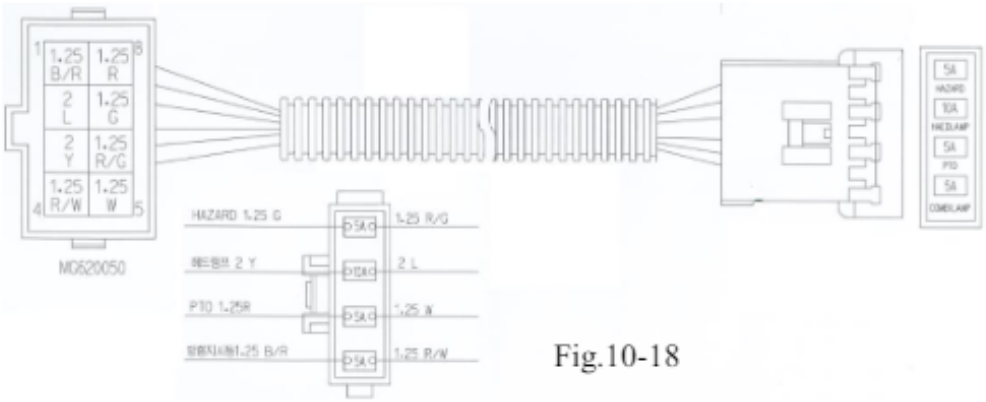


Fig.10-18

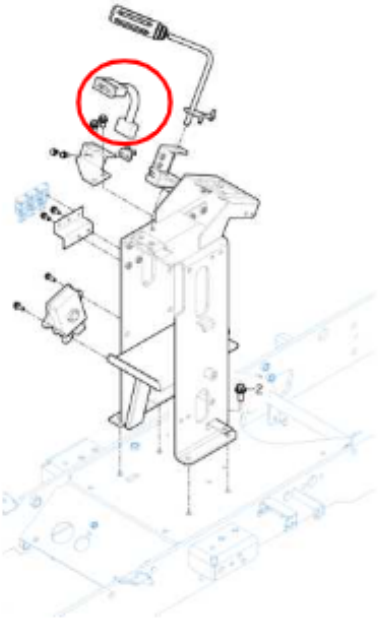


Fig.10-17 Fuse box

The circuit has 9 blade type fuses in its wiring circuit.

When a fuse has blown replace it with one of the same value.

Note : Using a large capacity fuse or wire burn out the wiring system.

Use fuse tongs to replace fuses.

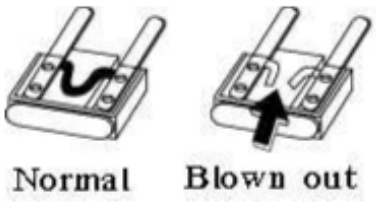


Fig.10-19

8.Trailer socket (Reference)

A hella's 7-pin trailer socket is equipped as an optional equipment.Lamp on a trailer can be operated through the socket.

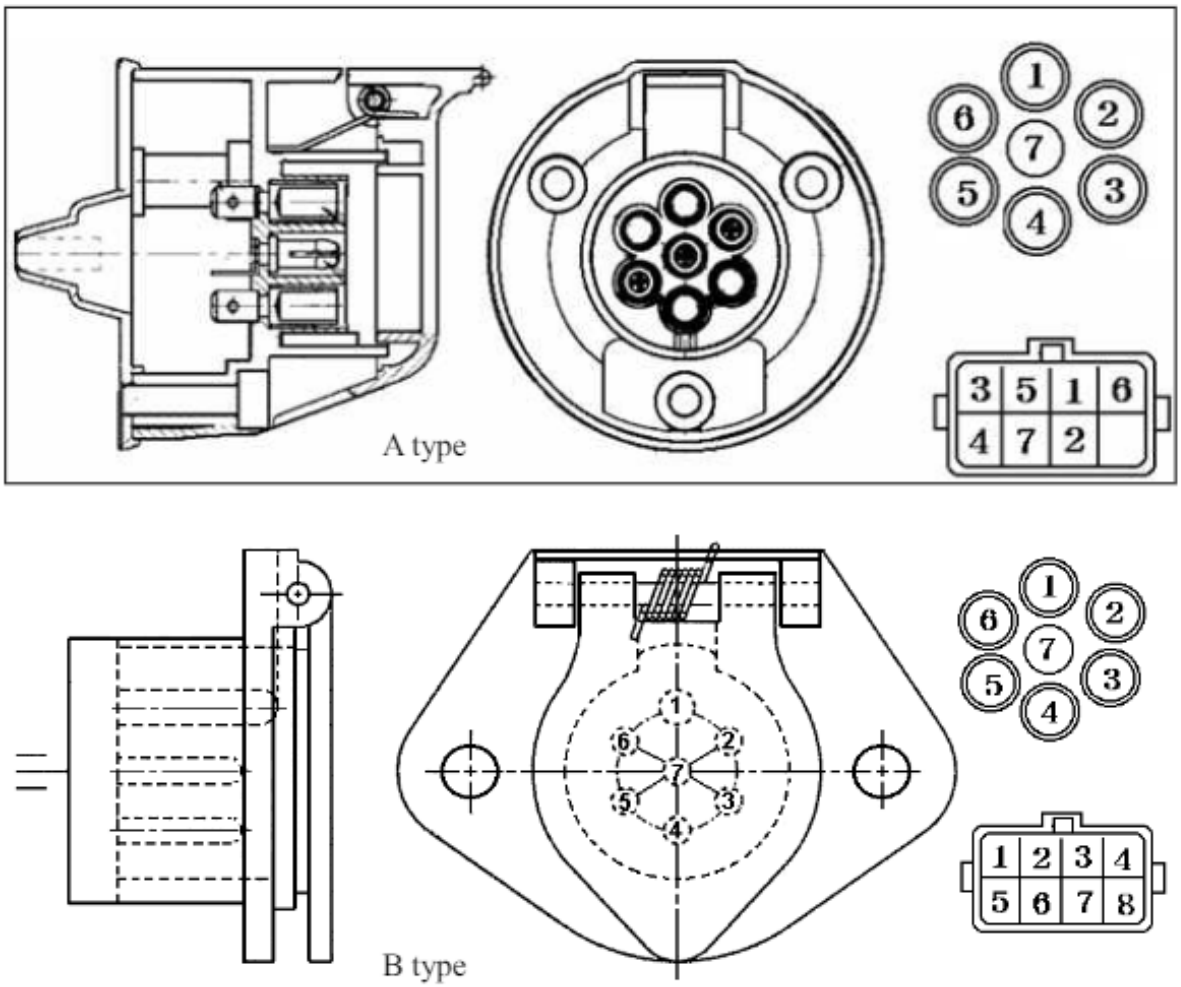
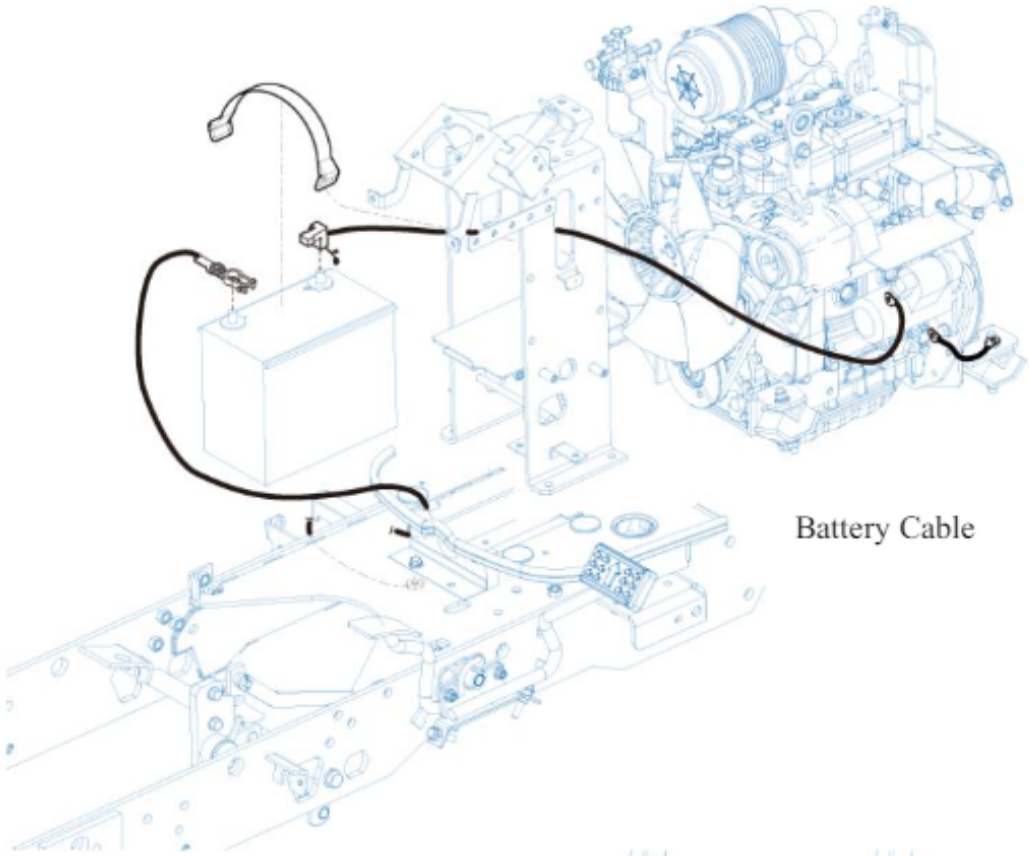


Fig.10-23

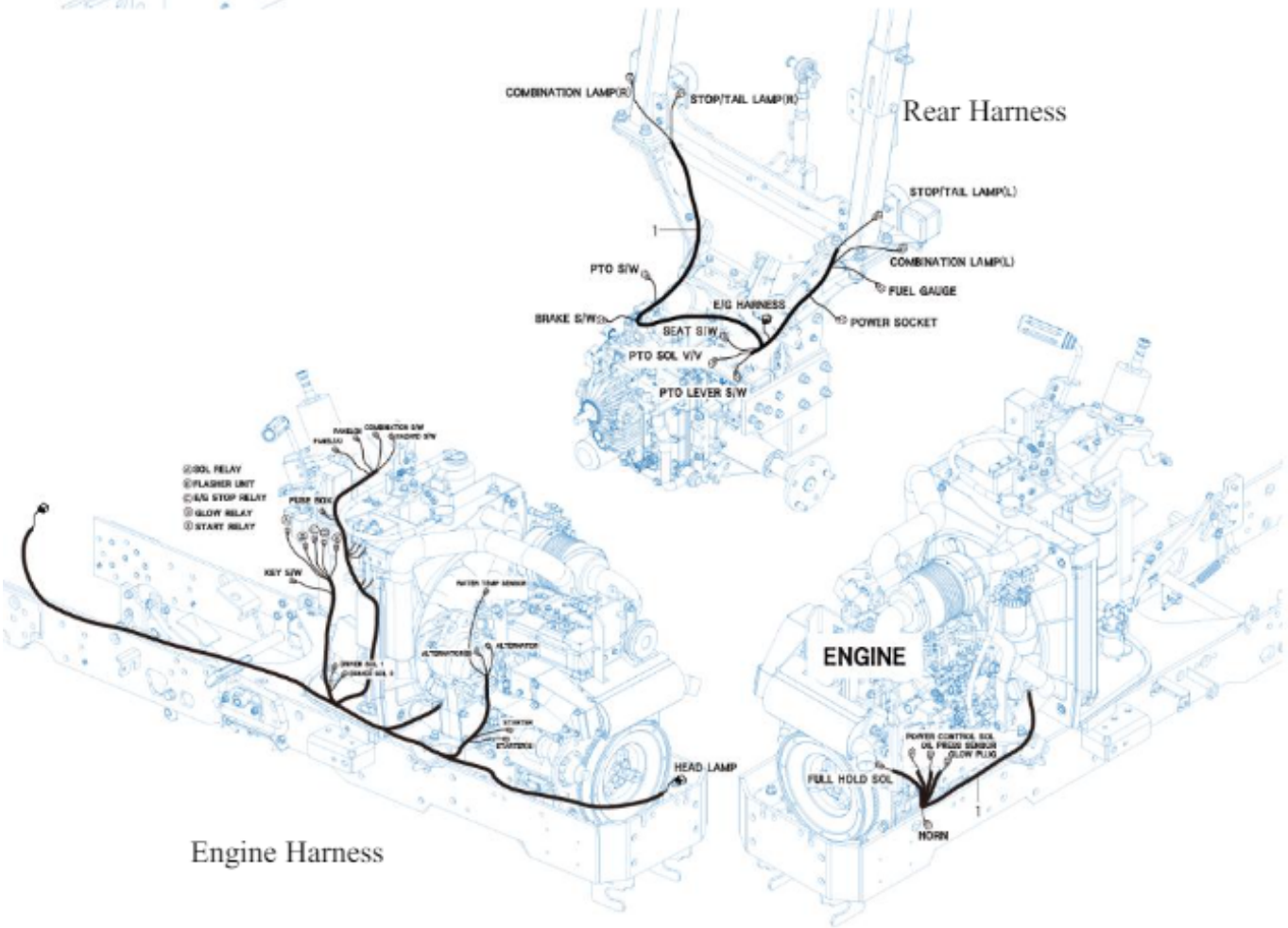
Wire Housing	Description		Color		Specification	
	A type	B type	A type	B type	A type	B type
1	Turn signal (LH)	Earth	G/B	W	AV 0.85	AV 1.25
2	Reserve light (Fog light)	Small light(Tail light)	R/W	B	AV 0.85	AV 1.25
3	Earth	Turn signal (LH)	B	Y	AV 2.0	AV 1.25
4	Turn signal (RH)	Stop Light	G/Y	R	AV 0.85	AV 1.25
5	Parking light (RH)	Turn signal (RH)	Y/W	G	AV 0.85	AV 1.25
6	Stop Light	Rear Light	W/L	Br	AV 0.85	AV 1.25
7	Parking light (LH)	Reserve light	Y	L	AV 0.85	AV 1.25

Note:

Lamp on the trailer should be of the same size or smaller than those on the trailer.



Battery Cable



Rear Harness

Engine Harness

Fig.10-24

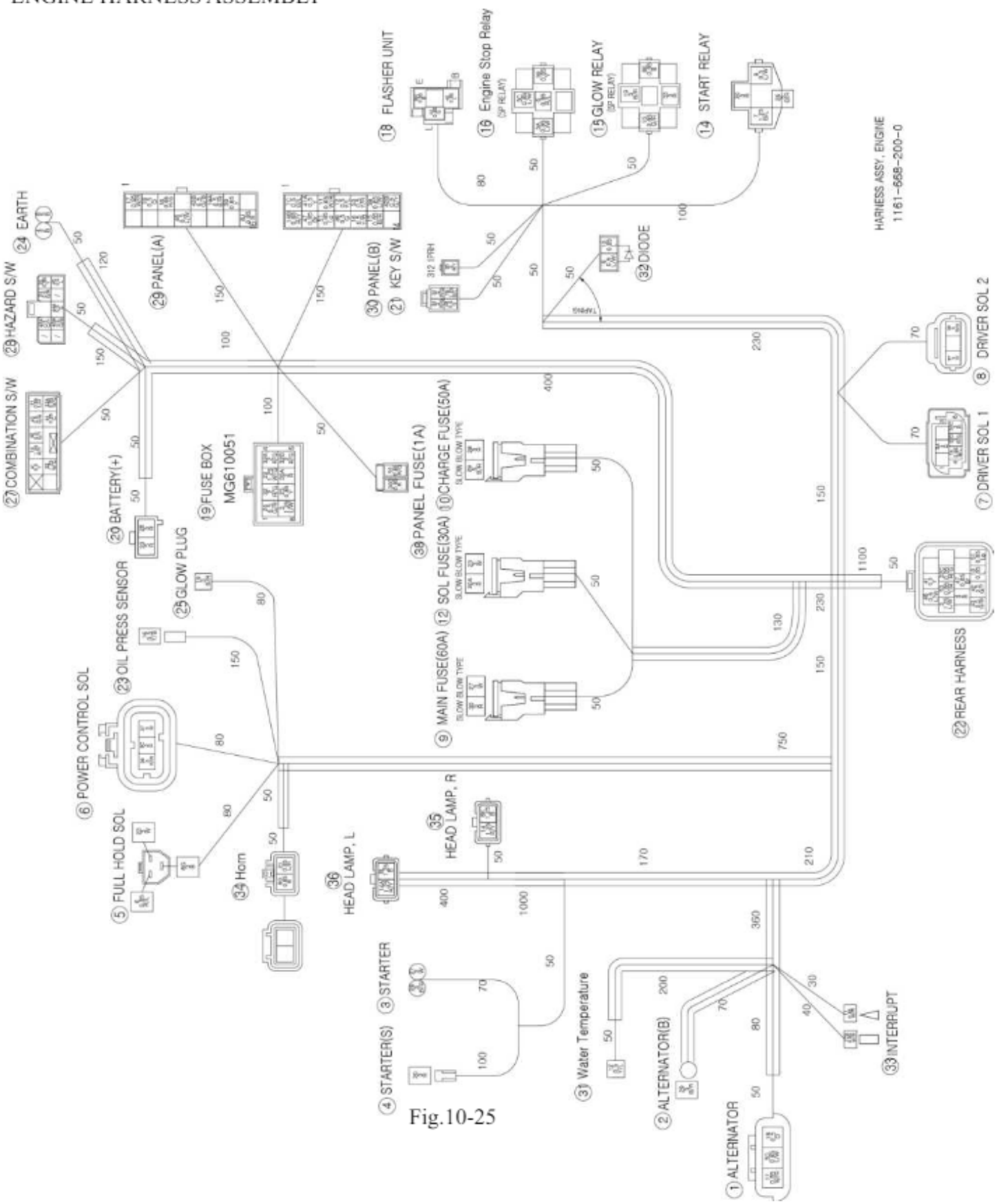

HARNESS ASSY, ENGINE
1161-868-200-0
⑱ FLASHER UNIT
⑯ Engine Stop Relay
⑮ GLOW RELAY
⑭ START RELAY
㉔ EARTH
㉙ HAZARD S/W
㉗ COMBINATION S/W
㉙ PANEL(A)
㉚ PANEL(B)
㉑ KEY S/W
㉜ DIODE
⑧ DRIVER SOL 2
⑦ DRIVER SOL 1
㉒ REAR HARNESS
⑲ FUSE BOX
MG610051
㉘ PANEL FUSE(1A)
⑩ CHARGE FUSE(50A)
⑫ SOL FUSE(30A)
⑨ MAIN FUSE(60A)
㉙ BATTERY(+)
㉕ GLOW PLUG
㉓ OIL PRESS SENSOR
⑥ POWER CONTROL SOL
⑤ FULL HOLD SOL
㉞ Horn
㉟ HEAD LAMP, R
㊱ HEAD LAMP, L
④ STARTER(S)
③ STARTER
㉛ Water Temperature
② ALTERNATOR(B)
① ALTERNATOR
㉝ INTERRUPT

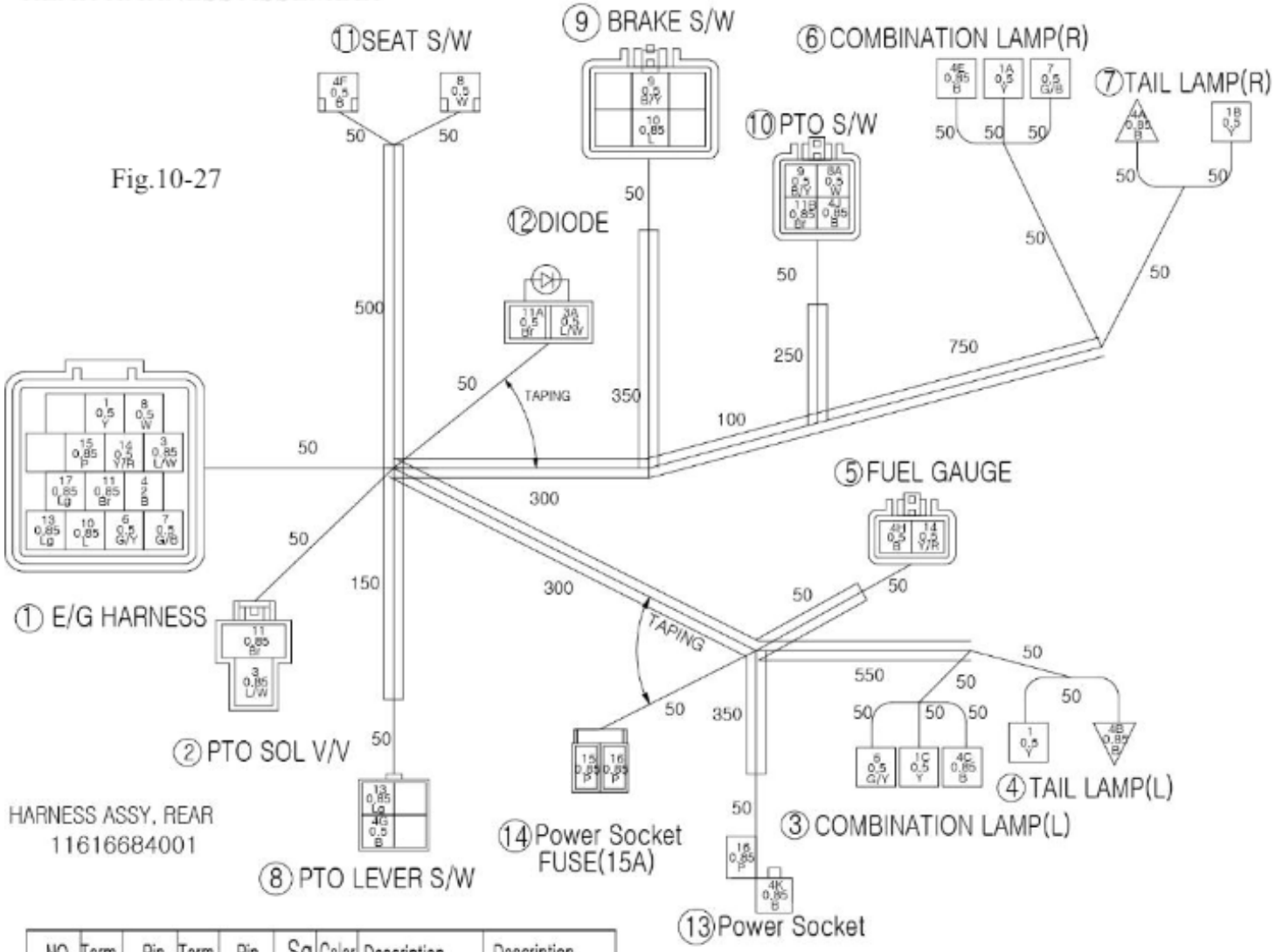
Fig.10-25

NO	Term.	Pin	Term.	Pin	Sq	Color	Description	Description
001	22	3	19	3	1.25	L/W	REAR HARNESS	FUSE BOX
002			16	3A	0.85	L/W	3-3	Engine Stop relay
003			30	3B	0.85	L/W	3-3	Meter Panel(B)
004			16	3C	0.85	L/W	3-3	Engine Stop relay
005			1	3D	0.85	L/W	3-3	ALTERNATOR
006	22	4	24	4	2	B	REAR HARNESS	EARTH
007	5	6	16	6	0.85	R/L	FULL HOLD SOL	Engine Stop relay
008	14	7			1.25	B/L	Starter Relay	7-7
009			7	7A	0.85	B/L	7-7	DRIVER SOL 1
010			21	7B	1.25	B/L	7-7	KEY S/W
011			30	7C	0.5	B/L	7-7	Meter Panel(B)
012	24	8		8	5	B	EARTH	
013			7	8A	3	B	8-8	DRIVER SOL 1
014			6	8C	3	B	8-8	P CONTROL SOL
015			34	8D	0.85	B	8-8	HORN
016			15	8E	0.85	B	8-8	GLOW RELAY
017			5	8G	3	B	8-8	FULL HOLD SOL
018			18	8H	0.5	B	8-8	FLASHER UNIT
019			29	8J	0.85	B	8-8	Meter Panel(A)
020			35	8K	1.25	B	8-8	HEAD LAMP, R
021			36	8L	1.25	B	8-8	HEAD LAMP, L
022	32	9	14	9	0.5	L/W	Diode	Starter Relay
023	22	10	32	10	0.85	L	REAR HARNESS	Diode
024	30	11	33	11	0.85	W/R	Meter Panel(B)	INTERRUPT
025	30	12	31	12	0.5	Y/L	Meter Panel(B)	Water Temp.
026	27	14	35	14	1.25	R/Y	Comb. S/W	HEAD LAMP, R
027			36	14A	1.25	R/Y	14-14	HEAD LAMP, L
028			30	14B	0.85	R/Y	14-14	Meter Panel(B)
029	30	15	15	15	0.85	B/R	Meter Panel(B)	GLOW RELAY
030	30	16	23	16	0.5	Y/B	Meter Panel(B)	OIL PRESS SENSOR
031	29	17	1	17	0.85	W/R	Meter Panel(A)	ALTERNATOR
032			33	17A	0.85	W/R	17-17	INTERRUPT
033	29	18	1	18	0.5	O	Meter Panel(B)	ALTERNATOR
034	15	19	25	19	5	B/R	GLOW RELAY	GLOW PLUG
035			29	19A	0.5	B/R	19-19	Meter Panel(A)
036	4	20	14	20	3	R	Starter(S)	Starter Relay
037			12	20A	3	R	20-20	SOL Fuse
038	27	21	34	21	0.85	L/R	Comb. S/W	HORN
039	19	22	27	22	1.25	W/G	FUSE BOX	Comb. S/W

NO	Term.	Pin	Term.	Pin	Sq	Color	Description	Description
040			27	22A	0.85	W/G	22-22	Comb. S/W
041	12	23	5	23	3	W	SOL FUSE	FULL HOLD SOL
042	19	24	28	24	0.5	G/R	FUSE BOX	HAZARD S/W
043	19	25	28	25	0.85	Y	FUSE BOX	HAZARD S/W
044	3	26	14	26	3	B/R	STARTER	Starter Relay
045	3	27	9	27	3	W	STARTER	MAIN FUSE(60A)
046	20	28	10	28	5	R	BATTERY(+)	CHARGE FUSE(50A)
047	2	29	10	29	5	B/R	ALTERNATOR(B)	CHARGE FUSE(50A)
048	9	30	21	30	3	R	MAIN FUSE(60A)	KEY S/W
049			19	30A	2	R	30-30	FUSE BOX
050			7	30C	3	R	30-30	DRIVER SOL 1
051			38	30D	0.85	R	30-30	PANEL FUSE
053	21	32	19	32	3	R/G	KEY S/W	FUSE BOX
054			19	32A	2	R/G	32-32	FUSE BOX
055			19	32B	2	R/G	32-32	FUSE BOX
056			22	32C	0.85	R/G	32-32	REAR HARNESS
057			7	32D	0.85	R/G	32-32	DRIVER SOL 1
058	15	33	20	33	3	R	GLOW RELAY	BATTERY(+)
059	6	37	8	37	3	W	P CONTROL SOL	DRIVER SOL 2
060	6	38	8	38	3	R/W	P CONTROL SOL	DRIVER SOL 2
061	29	39	16	39	0.85	Y	Meter Panel(A)	Engine Stop Sol
062	27	41	22	41	0.5	Y	Comb. S/W	REAR HARNESS
063			30	41A	0.5	Y	41-41	Meter Panel(B)
064	27	42	22	42	0.5	G/Y	Comb. S/W	REAR HARNESS
065			28	42A	0.5	G/Y	42-42	HAZARD S/W
066			30	42B	0.5	G/Y	42-42	Meter Panel(B)
067	27	43	22	43	0.5	G/B	Comb. S/W	REAR HARNESS
068			28	43A	0.5	G/B	42-42	HAZARD S/W
069			29	43B	0.5	G/B	42-42	Meter Panel(A)
070	27	44	18	44	0.85	G	Comb. S/W	FLASHER UNIT
071			28	44A	0.5	G	42-42	HAZARD S/W
072	28	45	18	45	0.85	L	HAZARD S/W	FLASHER UNIT
073	22	46	29	46	0.5	L/W	REAR HARNESS	Meter Panel(A)
074	22	47	30	47	0.85	Br	REAR HARNESS	Meter Panel(B)
075	21	48	30	48	0.5	G	KEY S/W	Meter Panel(B)
076	22	51	30	51	0.85	L	REAR HARNESS	Meter Panel(B)
077	22	53	30	53	0.85	Y/R	REAR HARNESS	Meter Panel(B)
078	38	55	29	55	0.85	R/G	PANEL FUSE	Meter Panel(A)

REAR HARNESS ASSEMBLY

Fig.10-27



NO	Term.	Pin	Term.	Pin	Sq	Color	Description	Description
001	1	1	4	1	0.5	Y	E/G HARNESS	STOP/TAIL(R)
002			6	1A	0.5	Y	1-1	COMBI(L)
003			7	1B	0.5	Y	1-1	STOP/TAIL(L)
004			3	1C	0.5	Y	1-1	COMBI(R)
005	1	3	2	3	0.85	L/W	E/G HARNESS	PTO SOL V/V
006			13	3A	0.5	L/W	3-3	Diode
007	1	4			2	B	E/G HARNESS	
008			7	4A	0.85	B	4-4	STOP/TAIL(L)
009			4	4B	0.85	B	4-4	STOP/TAIL(R)
010			3	4C	0.85	B	4-4	COMBI LAMP(R)
011			6	4E	0.85	B	4-4	COMBI LAMP(L)
012			11	4F	0.5	B	4-4	SEAT S/W
013			8	4G	0.5	B	4-4	PTO LEVER S/W
014			5	4H	0.5	B	4-4	FUEL GAUGE
015			10	4J	0.85	B	4-4	PTO S/W
016			13	4K	0.85	B	4-4	P Socket
017			15	4L	0.85	B	4-4	UNLOADING V/V
018	1	6	3	6	0.5	G/Y	E/G HARNESS	COMBI LAMP(R)
019	1	7	6	7	0.5	G/B	E/G HARNESS	COMBI LAMP(L)
020	1	8	11	8	0.5	W	E/G HARNESS	SEAT S/W
021			1	8A	0.5	W	11-11	PTO S/W
022	9	9	10	9	0.5	B/Y	PTO LEVER S/W	BRAKE S/W
023	1	10	10	10	0.85	L	E/G HARNESS	BRAKE S/W
024	1	11	2	11	0.85	Br	E/G HARNESS	PTO SOL
025			12	11A	0.5	Br	68-68	Diode
026			10	11B	0.85	Br	68-68	PTO S/W
027	1	13	8	13	0.85	Lg	E/G HARNESS	PTO LEVER S/W
028	1	14	5	14	0.5	Y/R	E/G HARNESS	FUEL GAUGE
029	1	15	14	15	0.85	P	E/G HARNESS	Power Socket FUSE
030	14	16	13	16	0.85	P	Power Socket FUSE	Power Socket

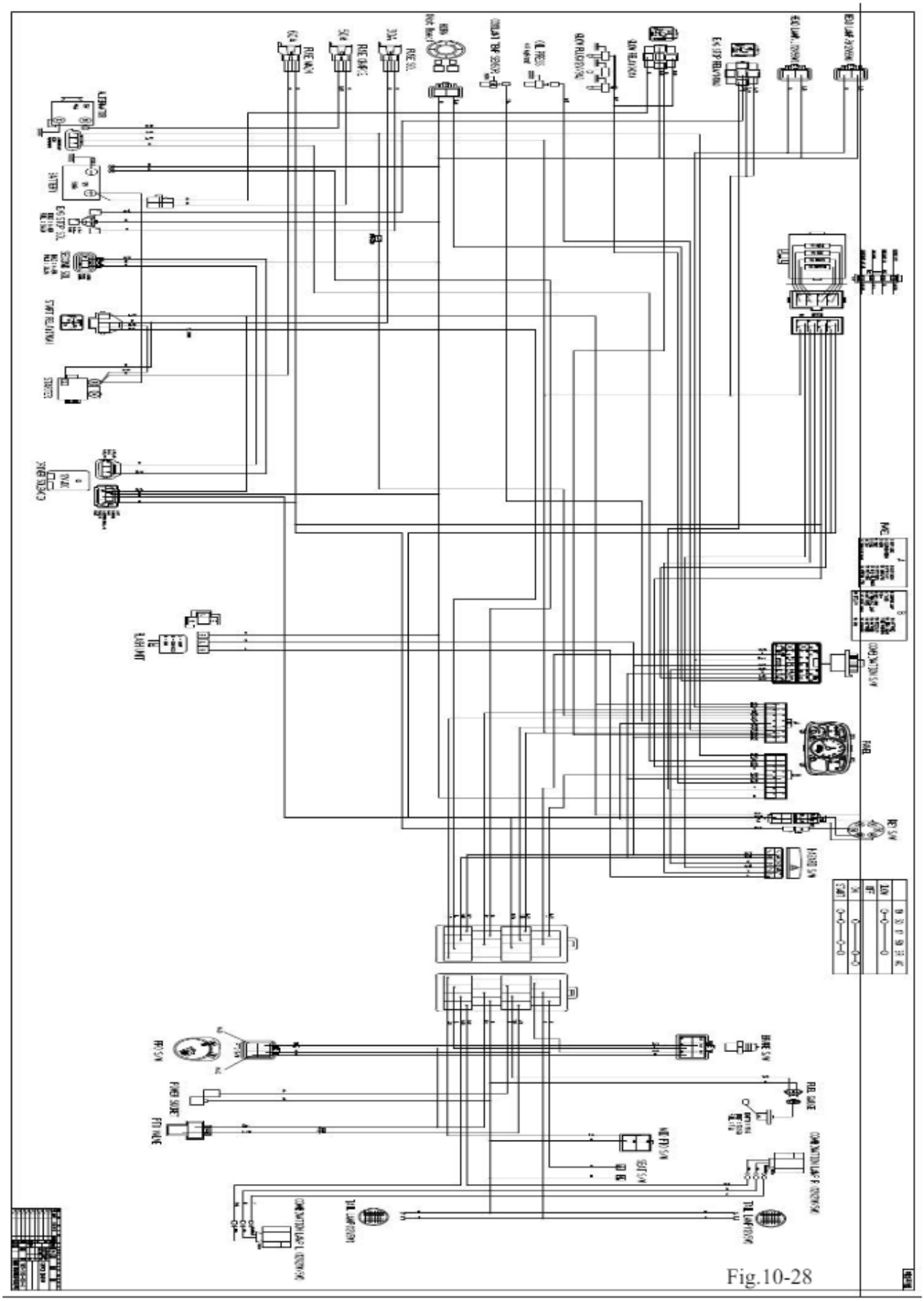


Fig.10-28

SECTION 7. TROUBLESHOOTING

Important: Whenever effecting a repair the reason for the cause of the problem must be investigated and corrected to avoid repeating failure.

The following table lists problems and their possible causes with the recommended remedial action

1. LIGHTING SYSTEM

Problems	Causes	Countermeasures
Several or all lights do not illuminate	Discharged battery	Check battery and charge or renew
	Loose or defective battery cable connection	Inspect,clean,and tighten connection
	Loose wire harness connectors	Check and ensure connectors securely engaged
	Burnt out fuse or fusible link	Inspect and renew.Check circuit before re-connecting power
	Faulty wiring	Check lighting Circuit wiring and repair or renew
	Defective light switch	Check and renew
	Several light bulbs burnt out due to defective voltage regulation	Check and renew voltage regulator (Alternator)
Individual lights do not illuminate	Burnt out bulb	Check and renew
	Defective or corroded bulb contact	Inspect,clean or renew
	Burnt out fuse	Inspect and renew.Check circuit before reconnecting power
	Loose or broken wires	Inspect ,secure,repair,or renew wiring
	Poor ground connection	Inspect,clean, and tighten ground connection
Lights burnt out repeatedly	Faulty voltage regulator	Check and renew voltage regulator (Alternator)
Turn signal lights do not illuminate	Blown fuse	Inspect and renew.Check circuit before re-connecting power
	Inoperative flasher unit	Check and renew
	Inoperative turn signal switch	Check and renew
	Defective wiring or connections	Inspect circuit,clean,and tighten connection. Repair or renew wiring if necessary

Problems	Causes	Countermeasures
Individual turn signal light does not illuminate	Burnt out bulb	Check and renew
	Corroded or loose bulb contacts	Inspect,clean,and renew
	Poor ground connection or damage wiring	Inspect,clean,and tighten connections or renew wiring
Turn signal pilot light is inoperative	Faulty bulb	Check and renew
	Defective flasher unit	Check and renew
	Faulty wiring or connections	Inspect,clean,and tighten connections or renew wiring
Stop lights does not illuminate	Inoperative stop light switch	Check and renew
	See “Individual lights do not illuminate”	See “Individual lights do not illuminate
Inoperative work light	Work light switch is not turned on	Ensure work light illuminates
	See “Individual lights do not illuminate	See “Individual lights do not illuminate

2. INSTRUMENTATION

Problems	Causes	Countermeasures
Inoperative or erratic meters	Loose or broken wiring	Inspect Circuit, tighten connections or renew wiring
	Defective meters	Inspect and renew
	Defective sensors	Check and renew
	Defective Voltage regulator	Check and renew voltage regulator (Alternator)
Monitor light does not illuminate	Loose or broken wiring	Inspect circuit,tighten connections or renew wiring
	Faulty main switch	Check and renew
	Burnt out bulb	Check and renew
	Burnt out fuse	Check and renew
	Defective switch	Check and renew
	Loose or broken wiring	Check and renew
PTO does not operate	Burnt out fuse	Inspect and renew.Check circuit
	Loose or broken wires or connections	Inspect circuit,tighten connections,or renew wiring
	Defective PTO switch	Check and renew
	Defective PTO solenoid	Check and renew

Problems	Causes	Countermeasures
Inoperative horn	Burnt out fuse	Inspect and renew.Check circuit before re-connecting power
	Loose or broken wires of connections	Inspect circuit,tighten connections,or renew wiring
	Defective horn switch	Check and renew
	Defective horn	Check and renew

3.GLOW SYSTEM

Problems	Causes	Countermeasures
All glow plugs do not heat red	Discharged Battery	Check battery and charge or renew
	Loose or defective battery cable connections	Inspect,clean,and tighten connections
	Loose wire harness connections	Check and ensure connectors securely engaged
	Burnt out fuse	Inspect and renew.Check circuit before re-connecting power
	Faulty wiring	Check glow plug circuit wiring and repair or renew
	Defective main switch	Check and renew
Individual glow plug does not glow	Defective glow plug	Check and renew
	Defective or corroded glow plug contacts	Inspect,Clean,or renew
	Loose or broken wires	Inspect,secure,repair,or renew wiring
Glow monitor light does not illuminate	Defective glow timer	Check and renew
	Defective glow monitor light or monitor and warning check unit	See " Light system troubleshooting"

4. STARTING SYSTEM

Problems	Causes	Countermeasures
Starter motor does not spin	Discharged battery	Check battery and charge or renew
	Defective stop light switch	Check and renew
	Defective key switch	Check and renew
	Defective starter motor connections or loose battery connections	Check,clean and tighten connections
	Faulty starter motor	Inspect,repair,or renew
	Defective master brake pedal	Inspect and try to push brake pedal
	Faulty reverse or forward pedal	Inspect ,adjust neutral
	Defective push switch	Check and renew
Engine cranks slowly	Discharged battery	Check battery and charge or renew
	Excessive resistance in starter circuit	Check circuit connections and repair or renew faulty wiring
	Defective starter motor	Refer to the engine manual
	Tight engine	Refer to the engine manual

5. CHARGING SYSTEM

Problems	Causes	Countermeasures
Battery is low in charge or discharge	Loose or worn alternator drive belt	Check and adjust belt tension or renew
	Defective battery:It will not accept or hold charge.Electrolyte level is low	Check condition of battery and renew
	Excessive resistance due to loose charging system connections	Check,clean,and tighten circuit connections
	Defective alternator	Check and repair or renew
Alternator is charging at high rate (Battery is overheating)	Defective battery	Check condition of battery and renew
	Defective Alternator	Check and repair or renew
No output from alternator	Alternator drive belt is broken	Renew and tension correctly
	Loose connection or broken cable in charge system	Inspect system,tighten connections and repair or renew faulty wiring
	Defective voltage regulator	Check and renew
	Defective alternator	Check and repair or renew

Problems	Causes	Countermeasures
Intermittent or low alternator output	Alternator drive belt is slipping	Check and adjust belt tension or renew
	Loose connection or broken cable in charge system	Inspect system,tighten connections and repair or renew faulty wiring
	Defective alternator	Check and repair or renew
Warning light dims	Faulty external charging circuit connections	Inspect system,clean and tighten connections
	Faulty rotor slip rings or brushes	Inspect and repair or renew
	Defective monitor and warning unit	Check and renew
	Faulty rectifier or rectifying diodes	Check and renew
Warning light is normal but battery is discharged	Defective voltage regulator	Check and renew
	Faulty starter	Check and renew
	Faulty rectifier or rectifying diodes	Check and renew
Warning light is lit during operation	Loose or worn alternator drive belt	Check and adjust tension or renew
	Defective diodes	Check and renew
	Faulty rotor,slip rings,or brushes	Inspect,repair,or renew
	Defective starter	Check and renew
	Defective rectifier or rectifying diodes	Check and renew
Warning light flashes intermittently	Faulty external charging circuit	Inspect circuit,clean,and tighten connections.Repair or renew faulty wiring
	Alternator's internal connections	Inspect and test circuitry,Repair or renew

CONVERSION TABLES

Millimeters to inches							
mm	in	mm	in	mm	in	mm	in
1	0.0394	26	1.0236	51	2.0079	76	2.9921
2	0.0787	27	1.0630	52	2.0472	77	3.0315
3	0.1181	28	1.1024	53	2.0866	78	3.0709
4	0.1575	29	1.1417	54	2.1260	79	3.1102
5	0.1969	30	1.1811	55	2.1654	80	3.1496
6	0.2362	31	1.2205	56	2.2047	81	3.1890
7	0.2756	32	1.2598	57	2.2441	82	3.2283
8	0.3150	33	1.2992	58	2.2835	83	3.2677
9	0.3543	34	1.3386	59	2.3228	84	3.3071
10	0.3937	35	1.3780	60	2.3622	85	3.3465
11	0.4331	36	1.4173	61	2.4016	86	3.3858
12	0.4724	37	1.4567	62	2.4409	87	3.4252
13	0.5118	38	1.4961	63	2.4803	88	3.4646
14	0.5512	39	1.5354	64	2.5197	89	3.5039
15	0.5906	40	1.5748	65	2.5591	90	3.5433
16	0.6299	41	1.6142	66	2.5984	91	3.5827
17	0.6693	42	1.6535	67	2.6378	92	3.6220
18	0.7087	43	1.6929	68	2.6772	93	3.6614
19	0.7480	44	1.7323	69	2.7165	94	3.7008
20	0.7874	45	1.7717	70	2.7559	95	3.7402
21	0.8268	46	1.8110	71	2.7953	96	3.7795
22	0.8661	47	1.8504	72	2.8346	97	3.8189
23	0.9055	48	1.8898	73	2.8740	98	3.8583
24	0.9449	49	1.9291	74	2.9134	99	3.8976
25	0.9843	50	1.9685	75	2.9528	100	3.9370

Inches to millimeters					
in	mm	in	mm	in	mm
1/64	0.3969	25/64	9.9219	13/16	20.6375
1/32	0.7938	13/32	10.3188	53/64	21.0344
3/64	1.1906	27/64	10.7156	27/32	21.4313
1/16	1.5875	7/16	11.1125	55/64	21.8281
5/64	1.9844	29/64	11.5094	7/8	22.2250
3/32	2.3813	15/32	11.9063	57/64	22.6219
7/64	2.7781	31/64	12.3031	29/32	23.0188
1/8	3.1750	1/2	12.7000	59/64	23.4156
9/64	3.5719	33/64	13.0969	15/16	23.8125
5/32	3.9688	17/32	13.4938	61/64	24.2094
11/64	4.3656	35/64	13.8906	31/32	24.6063
3/16	4.7625	9/16	14.2875	63/64	25.0031
13/64	5.1594	37/64	14.6844		
7/32	5.5563	19/32	15.0813		
15/64	5.9531	39/64	15.4781		
1/4	6.3500	5/8	15.8750		
17/64	6.7469	41/64	16.2719		
9/32	7.1438	21/32	16.6688		
19/64	7.5406	43/64	17.0656		
5/16	7.9375	11/16	17.4625		
21/64	8.3344	45/64	17.8594		
11/32	8.7313	23/32	18.2563		
23/64	9.1281	47/64	18.6531		
3/8	9.5250	3/4	19.0500		
		49/64	19.4469		
		25/32	19.8438		
		51/64	20.2406		

	Length				Feet to Meters						
ft	0	1	2	3	4	5	6	7	8	9	ft
	m	m	m	m	m	m	m	m	m	m	
0	0.0000	0.3050	0.6100	0.9150	1.2200	1.5250	1.8300	2.1350	2.4400	2.7450	0
10	8.0532	3.3550	3.6600	3.9650	4.2700	4.5750	4.8800	5.1850	5.4900	5.7950	10
20	21.1097	6.4050	6.7100	7.0150	7.3200	7.6250	7.9300	8.2350	8.5400	8.8450	20
30	34.1661	9.4550	9.7600	10.0650	10.3700	10.6750	10.9800	11.2850	11.5900	11.8950	30
40	47.2225	12.5050	12.8100	13.1150	13.4200	13.7250	14.0300	14.3350	14.6400	14.9450	40
50	60.2790	15.5550	15.8600	16.1650	16.4700	16.7750	17.0800	17.3850	17.6900	17.9950	50
60	73.3354	18.6050	18.9100	19.2150	19.5200	19.8250	20.1300	20.4350	20.7400	21.0450	60
70	86.3919	21.6550	21.9600	22.2650	22.5700	22.8750	23.1800	23.4850	23.7900	24.0950	70
80	99.4483	24.7050	25.0100	25.3150	25.6200	25.9250	26.2300	26.5350	26.8400	27.1450	80
90	112.5047	27.7550	28.0600	28.3650	28.6700	28.9750	29.2800	29.5850	29.8900	30.1950	90
100	125.5612	30.8050	31.1100	31.4150	31.7200	32.0250	32.3300	32.6350	32.9400	33.2450	100

	Meters to Feet										
m	0	1	2	3	4	5	6	7	8	9	m
	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	
0	0.0000	3.2808	6.5616	9.8424	13.1232	16.4040	19.6848	22.9656	26.2464	29.5272	0
10	32.8080	36.0888	39.3696	42.6504	45.9312	49.2120	52.4928	55.7736	59.0544	62.3352	10
20	65.6160	68.8968	72.1776	75.4584	78.7392	82.0200	85.3008	88.5816	91.8624	95.1432	20
30	98.4240	101.7048	104.9856	108.2664	111.5472	114.8280	118.1088	121.3896	124.6704	127.9512	30
40	131.2320	134.5128	137.7936	141.0744	144.3552	147.6360	150.9168	154.1976	157.4784	160.7592	40
50	164.0400	167.3208	170.6016	173.8824	177.1632	180.4440	183.7248	187.0056	190.2864	193.5672	50
60	196.8480	200.1288	203.4096	206.6904	209.9712	213.2520	216.5328	219.8136	223.0944	226.3752	60
70	229.6560	232.9368	236.2176	239.4984	242.7792	246.0600	249.3408	252.6216	255.9024	259.1832	70
80	262.4640	265.7448	269.0256	272.3064	275.5872	278.8680	282.1488	285.4296	288.7104	291.9912	80
90	295.2720	298.5528	301.8336	305.1144	308.3952	311.6760	314.9568	318.2376	321.5184	324.7992	90
100	328.0800	331.3608	334.6416	337.9224	341.2032	344.4840	347.7648	351.0456	354.3264	357.6072	100

	Mile to kilometers										
miles	0	1	2	3	4	5	6	7	8	9	miles
	Km	Km	Km	Km	Km	Km	Km	Km	Km	Km	
0	0.000	1.609	3.218	4.827	6.436	8.045	9.654	11.263	12.872	14.481	0
10	16.090	17.699	19.308	20.917	22.526	24.135	25.744	27.353	28.962	30.571	10
20	32.180	33.789	35.398	37.007	38.616	40.225	41.834	43.443	45.052	46.661	20
30	48.270	49.879	51.488	53.097	54.706	56.315	57.924	59.533	61.142	62.751	30
40	64.360	65.969	67.578	69.187	70.796	72.405	74.014	75.623	77.232	78.841	40
50	80.450	82.059	83.668	85.277	86.886	88.495	90.104	91.713	93.322	94.931	50
60	96.540	98.149	99.758	101.367	102.976	104.585	106.194	107.803	109.412	111.021	60
70	112.630	114.239	115.848	117.457	119.066	120.675	122.284	123.893	125.502	127.111	70
80	128.720	130.329	131.938	133.547	135.156	136.765	138.374	139.983	141.592	143.201	80
90	144.810	146.419	148.028	149.637	151.246	152.855	154.464	156.073	157.682	159.291	90
100	160.900	162.509	164.118	165.727	167.336	168.945	170.554	172.163	173.772	175.381	100

	kilometers to Miles										
Km	0	1	2	3	4	5	6	7	8	9	Km
	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles	
0	0.000	0.621	1.242	1.863	2.484	3.105	3.726	4.347	4.968	5.589	0
10	6.210	6.831	7.452	8.073	8.694	9.315	9.936	10.557	11.178	11.799	10
20	12.420	13.041	13.662	14.283	14.904	15.525	16.146	16.767	17.388	18.009	20
30	18.630	19.251	19.872	20.493	21.114	21.735	22.356	22.977	23.598	24.219	30
40	24.840	25.461	26.082	26.703	27.324	27.945	28.566	29.187	29.808	30.429	40
50	31.050	31.671	32.292	32.913	33.534	34.155	34.776	35.397	36.018	36.639	50
60	37.260	37.881	38.502	39.123	39.744	40.365	40.986	41.607	42.228	42.849	60
70	43.470	44.091	44.712	45.333	45.954	46.575	47.196	47.817	48.438	49.059	70
80	49.680	50.301	50.922	51.543	52.164	52.785	53.406	54.027	54.648	55.269	80
90	55.890	56.511	57.132	57.753	58.374	58.995	59.616	60.237	60.858	61.479	90
100	62.100	62.721	63.342	63.963	64.584	65.205	65.826	66.447	67.068	67.689	100

	Area				Square inches to square centimeters						
in2	0	1	2	3	4	5	6	7	8	9	in2
	cm2	cm2	cm2	cm2	cm2	cm2	cm2	cm2	cm2	cm2	
0	0.000	6.462	12.924	19.386	25.848	32.310	38.772	45.234	51.696	58.158	0
10	64.620	71.082	77.544	84.006	90.468	96.930	103.392	109.854	116.316	122.778	10
20	129.240	135.702	142.164	148.626	155.088	161.550	168.012	174.474	180.936	187.398	20
30	193.860	200.322	206.784	213.246	219.708	226.170	232.632	239.094	245.556	252.018	30
40	258.480	264.942	271.404	277.866	284.328	290.790	297.252	303.714	310.176	316.638	40
50	323.100	329.562	336.024	342.486	348.948	355.410	361.872	368.334	374.796	381.258	50
60	387.720	394.182	400.644	407.106	413.568	420.030	426.492	432.954	439.416	445.878	60
70	452.340	458.802	465.264	471.726	478.188	484.650	491.112	497.574	504.036	510.498	70
80	516.960	523.422	529.884	536.346	542.808	549.270	555.732	562.194	568.656	575.118	80
90	581.580	588.042	594.504	600.966	607.428	613.890	620.352	626.814	633.276	639.738	90
100	646.200	652.662	659.124	665.586	672.048	678.510	684.972	691.434	697.896	704.358	100

					Square centimeters to Square inches						
cm2	0	1	2	3	4	5	6	7	8	9	cm2
	in2	in2	in2	in2	in2	in2	in2	in2	in2	in2	
0	0.000	0.155	0.310	0.465	0.620	0.775	0.930	1.085	1.240	1.395	0
10	1.550	1.705	1.860	2.015	2.170	2.325	2.480	2.635	2.790	2.945	10
20	3.100	3.255	3.410	3.565	3.720	3.875	4.030	4.185	4.340	4.495	20
30	4.650	4.805	4.960	5.115	5.270	5.425	5.580	5.735	5.890	6.045	30
40	6.200	6.355	6.510	6.665	6.820	6.975	7.130	7.285	7.440	7.595	40
50	7.750	7.905	8.060	8.215	8.370	8.525	8.680	8.835	8.990	9.145	50
60	9.300	9.455	9.610	9.765	9.920	10.075	10.230	10.385	10.540	10.695	60
70	10.850	11.005	11.160	11.315	11.470	11.625	11.780	11.935	12.090	12.245	70
80	12.400	12.555	12.710	12.865	13.020	13.175	13.330	13.485	13.640	13.795	80
90	13.950	14.105	14.260	14.415	14.570	14.725	14.880	15.035	15.190	15.345	90
100	15.500	15.655	15.810	15.965	16.120	16.275	16.430	16.585	16.740	16.895	100

					Cubic inches to Cubic Centimeters						
in3	0	1	2	3	4	5	6	7	8	9	in3
	cm3(cc)	cm3(cc)	cm3(cc)	cm3(cc)	cm3(cc)	cm3(cc)	cm3(cc)	cm3(cc)	cm3(cc)	cm3(cc)	
0	0.000	16.387	32.774	49.161	65.548	81.935	98.322	114.709	131.096	147.483	0
10	163.870	180.257	196.644	213.031	229.418	245.805	262.192	278.579	294.966	311.353	10
20	327.740	344.127	360.514	376.901	393.288	409.675	426.062	442.449	458.836	475.223	20
30	491.610	507.997	524.384	540.771	557.158	573.545	589.932	606.319	622.706	639.093	30
40	655.480	671.867	688.254	704.641	721.028	737.415	753.802	770.189	786.576	802.963	40
50	819.350	835.737	852.124	868.511	884.898	901.285	917.672	934.059	950.446	966.833	50
60	983.220	999.607	1015.994	1032.381	1048.768	1065.155	1081.542	1097.929	1114.316	1130.703	60
70	1147.090	1163.477	1179.864	1196.251	1212.638	1229.025	1245.412	1261.799	1278.186	1294.573	70
80	1310.960	1327.347	1343.734	1360.121	1376.508	1392.895	1409.282	1425.669	1442.056	1458.443	80
90	1474.830	1491.217	1507.604	1523.991	1540.378	1556.765	1573.152	1589.539	1605.926	1622.313	90
100	1638.700	1655.087	1671.474	1687.861	1704.248	1720.635	1737.022	1753.409	1769.796	1786.183	100

					Cubic Centimeters to cubic inches						
cm3(cc)	0	1	2	3	4	5	6	7	8	9	cm3(cc)
	in3	in3	in3	in3	in3	in3	in3	in3	in3	in3	
0	0.0000	0.0610	0.1221	0.1831	0.2441	0.3051	0.3662	0.4272	0.4882	0.5492	0
10	0.6103	0.6713	0.7323	0.7933	0.8544	0.9154	0.9764	1.0374	1.0985	1.1595	10
20	1.2205	1.2815	1.3426	1.4036	1.4646	1.5256	1.5867	1.6477	1.7087	1.7697	20
30	1.8308	1.8918	1.9528	2.0138	2.0749	2.1359	2.1969	2.2579	2.3190	2.3800	30
40	2.4410	2.5020	2.5631	2.6241	2.6851	2.7461	2.8072	2.8682	2.9292	2.9902	40
50	3.0513	3.1123	3.1733	3.2343	3.2954	3.3564	3.4174	3.4784	3.5395	3.6005	50
60	3.6615	3.7225	3.7836	3.8446	3.9056	3.9666	4.0277	4.0887	4.1497	4.2107	60
70	4.2718	4.3328	4.3938	4.4548	4.5159	4.5769	4.6379	4.6989	4.7600	4.8210	70
80	4.8820	4.9430	5.0041	5.0651	5.1261	5.1871	5.2482	5.3092	5.3702	5.4312	80
90	5.4923	5.5533	5.6143	5.6753	5.7364	5.7974	5.8584	5.9194	5.9805	6.0415	90
100	6.1025	6.1635	6.2246	6.2856	6.3466	6.4076	6.4687	6.5297	6.5907	6.6517	100

	Volume	Gallons(U.S) to Liters									
US gal	0	1	2	3	4	5	6	7	8	9	US gal
	Liters	Liters	Liters	Liters	Liters	Liters	Liters	Liters	Liters	Liters	
0	0.000	3.785	7.571	11.356	15.142	18.927	22.712	26.498	30.283	34.069	0
10	37.854	41.639	45.425	49.210	52.996	56.781	60.566	64.352	68.137	71.923	10
20	75.708	79.493	83.279	87.064	90.850	94.635	98.420	102.206	105.991	109.777	20
30	113.562	117.347	121.133	124.918	128.704	132.489	136.274	140.060	143.845	147.631	30
40	151.416	155.201	158.987	162.772	166.558	170.343	174.128	177.914	181.699	185.485	40
50	189.270	193.055	196.841	200.626	204.412	208.197	211.982	215.768	219.553	223.339	50
60	227.124	230.909	234.695	238.480	242.266	246.051	249.836	253.622	257.407	261.193	60
70	264.978	268.763	272.549	276.334	280.120	283.905	287.690	291.476	295.261	299.047	70
80	302.832	306.617	310.403	314.188	317.974	321.759	325.544	329.330	333.115	336.901	80
90	340.686	344.471	348.257	352.042	355.828	359.613	363.398	367.184	370.969	374.755	90
100	378.540	382.325	386.111	389.896	393.682	397.467	401.252	405.038	408.823	412.609	100

	Liters to Gallons(U.S)										
Liters	0	1	2	3	4	5	6	7	8	9	Liters
	US gal	US gal	US gal	US gal	US gal	US gal	US gal	US gal	US gal	US gal	
0	0.000	0.264	0.528	0.793	1.057	1.321	1.585	1.849	2.114	2.378	0
10	2.642	2.906	3.170	3.435	3.699	3.963	4.227	4.491	4.756	5.020	10
20	5.284	5.548	5.812	6.077	6.341	6.605	6.869	7.133	7.398	7.662	20
30	7.926	8.190	8.454	8.719	8.983	9.247	9.511	9.775	10.040	10.304	30
40	10.568	10.832	11.096	11.361	11.625	11.889	12.153	12.417	12.682	12.946	40
50	13.210	13.474	13.738	14.003	14.267	14.531	14.795	15.059	15.324	15.588	50
60	15.852	16.116	16.380	16.645	16.909	17.173	17.437	17.701	17.966	18.230	60
70	18.494	18.758	19.022	19.287	19.551	19.815	20.079	20.343	20.608	20.872	70
80	21.136	21.400	21.664	21.929	22.193	22.457	22.721	22.985	23.250	23.514	80
90	23.778	24.042	24.306	24.571	24.835	25.099	25.363	25.627	25.892	26.156	90
100	26.420	26.684	26.948	27.213	27.477	27.741	28.005	28.269	28.534	28.798	100

	Gallons(IMP.) to Liters										
Imp. ga	0	1	2	3	4	5	6	7	8	9	Imp. gal
	Liters	Liters	Liters	Liters	Liters	Liters	Liters	Liters	Liters	Liters	
0	0.0000	4.5460	9.0920	13.6380	18.1840	22.7300	27.2760	31.8220	36.3680	40.9140	0
10	45.4600	50.0060	54.5520	59.0980	63.6440	68.1900	72.7360	77.2820	81.8280	86.3740	10
20	90.9200	95.4660	100.0120	104.5580	109.1040	113.6500	118.1960	122.7420	127.2880	131.8340	20
30	136.3800	140.9260	145.4720	150.0180	154.5640	159.1100	163.6560	168.2020	172.7480	177.2940	30
40	181.8400	186.3860	190.9320	195.4780	200.0240	204.5700	209.1160	213.6620	218.2080	222.7540	40
50	227.3000	231.8460	236.3920	240.9380	245.4840	250.0300	254.5760	259.1220	263.6680	268.2140	50
60	272.7600	277.3060	281.8520	286.3980	290.9440	295.4900	300.0360	304.5820	309.1280	313.6740	60
70	318.2200	322.7660	327.3120	331.8580	336.4040	340.9500	345.4960	350.0420	354.5880	359.1340	70
80	363.6800	368.2260	372.7720	377.3180	381.8640	386.4100	390.9560	395.5020	400.0480	404.5940	80
90	409.1400	413.6860	418.2320	422.7780	427.3240	431.8700	436.4160	440.9620	445.5080	450.0540	90
100	454.6000	459.1460	463.6920	468.2380	472.7840	477.3300	481.8760	486.4220	490.9680	495.5140	100

	Liters to Gallons(IMP)										
Liters	0	1	2	3	4	5	6	7	8	9	Liters
	gal	gal	gal	gal	gal	gal	gal	gal	gal	gal	
0	0.0000	0.2200	0.4400	0.6600	0.8800	1.1000	1.3200	1.5400	1.7600	1.9800	0
10	2.2000	2.4200	2.6400	2.8600	3.0800	3.3000	3.5200	3.7400	3.9600	4.1800	10
20	4.4000	4.6200	4.8400	5.0600	5.2800	5.5000	5.7200	5.9400	6.1600	6.3800	20
30	6.6000	6.8200	7.0400	7.2600	7.4800	7.7000	7.9200	8.1400	8.3600	8.5800	30
40	8.8000	9.0200	9.2400	9.4600	9.6800	9.9000	10.1200	10.3400	10.5600	10.7800	40
50	11.0000	11.2200	11.4400	11.6600	11.8800	12.1000	12.3200	12.5400	12.7600	12.9800	50
60	13.2000	13.4200	13.6400	13.8600	14.0800	14.3000	14.5200	14.7400	14.9600	15.1800	60
70	15.4000	15.6200	15.8400	16.0600	16.2800	16.5000	16.7200	16.9400	17.1600	17.3800	70
80	17.6000	17.8200	18.0400	18.2600	18.4800	18.7000	18.9200	19.1400	19.3600	19.5800	80
90	19.8000	20.0200	20.2400	20.4600	20.6800	20.9000	21.1200	21.3400	21.5600	21.7800	90
100	22.0000	22.2200	22.4400	22.6600	22.8800	23.1000	23.3200	23.5400	23.7600	23.9800	100

	MASS					Pounds to Kilograms					
lbs	0	1	2	3	4	5	6	7	8	9	lbs
	Kg	Kg	Kg	Kg	Kg	Kg	Kg	Kg	Kg	Kg	
0	0.000	0.454	0.907	1.361	1.814	2.268	2.722	3.175	3.629	4.082	0
10	4.536	4.990	5.443	5.897	6.350	6.804	7.258	7.711	8.165	8.618	10
20	9.072	9.526	9.979	10.433	10.886	11.340	11.794	12.247	12.701	13.154	20
30	13.608	14.062	14.515	14.969	15.422	15.876	16.330	16.783	17.237	17.690	30
40	18.144	18.598	19.051	19.505	19.958	20.412	20.866	21.319	21.773	22.226	40
50	22.680	23.134	23.587	24.041	24.494	24.948	25.402	25.855	26.309	26.762	50
60	27.216	27.670	28.123	28.577	29.030	29.484	29.938	30.391	30.845	31.298	60
70	31.752	32.206	32.659	33.113	33.566	34.020	34.474	34.927	35.381	35.834	70
80	36.288	36.742	37.195	37.649	38.102	38.556	39.010	39.463	39.917	40.370	80
90	40.824	41.278	41.731	42.185	42.638	43.092	43.546	43.999	44.453	44.906	90
100	45.360	45.814	46.267	46.721	47.174	47.628	48.082	48.535	48.989	49.442	100

						Kilograms to pound					
Kg	0	1	2	3	4	5	6	7	8	9	Kg
	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	
0	0.000	2.205	4.409	6.614	8.818	11.023	13.228	15.432	17.637	19.841	0
10	22.046	24.251	26.455	28.660	30.864	33.069	35.274	37.478	39.683	41.887	10
20	44.092	46.297	48.501	50.706	52.910	55.115	57.320	59.524	61.729	63.933	20
30	66.138	68.343	70.547	72.752	74.956	77.161	79.366	81.570	83.775	85.979	30
40	88.184	90.389	92.593	94.798	97.002	99.207	101.412	103.616	105.821	108.025	40
50	110.230	112.435	114.639	116.844	119.048	121.253	123.458	125.662	127.867	130.071	50
60	132.276	134.481	136.685	138.890	141.094	143.299	145.504	147.708	149.913	152.117	60
70	154.322	156.527	158.731	160.936	163.140	165.345	167.550	169.754	171.959	174.163	70
80	176.368	178.573	180.777	182.982	185.186	187.391	189.596	191.800	194.005	196.209	80
90	198.414	200.619	202.823	205.028	207.232	209.437	211.642	213.846	216.051	218.255	90
100	220.460	222.665	224.869	227.074	229.278	231.483	233.688	235.892	238.097	240.301	100

						Kilograms to Newton					
Kg	0	1	2	3	4	5	6	7	8	9	Kg
	N	N	N	N	N	N	N	N	N	N	
0	0.000	9.807	19.614	29.421	39.228	49.035	58.842	68.649	78.456	88.263	0
10	98.070	107.877	117.684	127.491	137.298	147.105	156.912	166.719	176.526	186.333	10
20	196.140	205.947	215.754	225.561	235.368	245.175	254.982	264.789	274.596	284.403	20
30	294.210	304.017	313.824	323.631	333.438	343.245	353.052	362.859	372.666	382.473	30
40	392.280	402.087	411.894	421.701	431.508	441.315	451.122	460.929	470.736	480.543	40
50	490.350	500.157	509.964	519.771	529.578	539.385	549.192	558.999	568.806	578.613	50
60	588.420	598.227	608.034	617.841	627.648	637.455	647.262	657.069	666.876	676.683	60
70	686.490	696.297	706.104	715.911	725.718	735.525	745.332	755.139	764.946	774.753	70
80	784.560	794.367	804.174	813.981	823.788	833.595	843.402	853.209	863.016	872.823	80
90	882.630	892.437	902.244	912.051	921.858	931.665	941.472	951.279	961.086	970.893	90
100	980.700	990.507	1000.314	1010.121	1019.928	1029.735	1039.542	1049.349	1059.156	1068.963	100

						Newton to Kilograms					
N	0	1	2	3	4	5	6	7	8	9	N
	Kg	Kg	Kg	Kg	Kg	Kg	Kg	Kg	Kg	Kg	
0	0.000	1.020	2.039	3.059	4.079	5.099	6.118	7.138	8.158	9.177	0
10	10.197	11.217	12.236	13.256	14.276	15.296	16.315	17.335	18.355	19.374	10
20	20.394	21.414	22.433	23.453	24.473	25.493	26.512	27.532	28.552	29.571	20
30	30.591	31.611	32.630	33.650	34.670	35.690	36.709	37.729	38.749	39.768	30
40	40.788	41.808	42.827	43.847	44.867	45.887	46.906	47.926	48.946	49.965	40
50	50.985	52.005	53.024	54.044	55.064	56.084	57.103	58.123	59.143	60.162	50
60	61.182	62.202	63.221	64.241	65.261	66.281	67.300	68.320	69.340	70.359	60
70	71.379	72.399	73.418	74.438	75.458	76.478	77.497	78.517	79.537	80.556	70
80	81.576	82.596	83.615	84.635	85.655	86.675	87.694	88.714	89.734	90.753	80
90	91.773	92.793	93.812	94.832	95.852	96.872	97.891	98.911	99.931	100.950	90
100	101.970	102.990	104.009	105.029	106.049	107.069	108.088	109.108	110.128	111.147	100

	Pressure	Pounds per square inches to Kilograms per square centimeters									
b/in2(PSI	0	1	2	3	4	5	6	7	8	9	lb/in2(PSI)
	Kg/cm2	Kg/cm2	Kg/cm2	Kg/cm2	Kg/cm2	Kg/cm2	Kg/cm2	Kg/cm2	Kg/cm2	Kg/cm2	
0	0.0000	0.0703	0.1406	0.2109	0.2812	0.3516	0.4219	0.4922	0.5625	0.6328	0
10	0.7031	0.7734	0.8437	0.9140	0.9843	1.0547	1.1250	1.1953	1.2656	1.3359	10
20	1.4062	1.4765	1.5468	1.6171	1.6874	1.7578	1.8281	1.8984	1.9687	2.0390	20
30	2.1093	2.1796	2.2499	2.3202	2.3905	2.4609	2.5312	2.6015	2.6718	2.7421	30
40	2.8124	2.8827	2.9530	3.0233	3.0936	3.1640	3.2343	3.3046	3.3749	3.4452	40
50	3.5155	3.5858	3.6561	3.7264	3.7967	3.8671	3.9374	4.0077	4.0780	4.1483	50
60	4.2186	4.2889	4.3592	4.4295	4.4998	4.5702	4.6405	4.7108	4.7811	4.8514	60
70	4.9217	4.9920	5.0623	5.1326	5.2029	5.2733	5.3436	5.4139	5.4842	5.5545	70
80	5.6248	5.6951	5.7654	5.8357	5.9060	5.9764	6.0467	6.1170	6.1873	6.2576	80
90	6.3279	6.3982	6.4685	6.5388	6.6091	6.6795	6.7498	6.8201	6.8904	6.9607	90
100	7.0310	7.1013	7.1716	7.2419	7.3122	7.3826	7.4529	7.5232	7.5935	7.6638	100

	Kilograms per square centimeters to Pounds per square inches										
Kg/cm2	0	1	2	3	4	5	6	7	8	9	Kg/cm2
	lb/in2(psi)	lb/in2(psi)	lb/in2(psi)	lb/in2(psi)	lb/in2(psi)	lb/in2(psi)	lb/in2(psi)	lb/in2(psi)	lb/in2(psi)	lb/in2(psi)	
0	0.00	14.22	28.45	42.67	56.89	71.12	85.34	99.56	113.78	128.01	0
10	142.23	156.45	170.68	184.90	199.12	213.35	227.57	241.79	256.01	270.24	10
20	284.46	298.68	312.91	327.13	341.35	355.58	369.80	384.02	398.24	412.47	20
30	426.69	440.91	455.14	469.36	483.58	497.81	512.03	526.25	540.47	554.70	30
40	568.92	583.14	597.37	611.59	625.81	640.04	654.26	668.48	682.70	696.93	40
50	711.15	725.37	739.60	753.82	768.04	782.27	796.49	810.71	824.93	839.16	50
60	853.38	867.60	881.83	896.05	910.27	924.50	938.72	952.94	967.16	981.39	60
70	995.61	1009.83	1024.06	1038.28	1052.50	1066.73	1080.95	1095.17	1109.39	1123.62	70
80	1137.84	1152.06	1166.29	1180.51	1194.73	1208.96	1223.18	1237.40	1251.62	1265.85	80
90	1280.07	1294.29	1308.52	1322.74	1336.96	1351.19	1365.41	1379.63	1393.85	1408.08	90
100	1422.30	1436.52	1450.75	1464.97	1479.19	1493.42	1507.64	1521.86	1536.08	1550.31	100

	Kilograms per square centimeters to Kilo pascal										
Kg/cm2	0	1	2	3	4	5	6	7	8	9	Kg/cm2
	Kpa	Kpa	Kpa	Kpa	Kpa	Kpa	Kpa	Kpa	Kpa	Kpa	
0	0.0	98.1	196.1	294.2	392.3	490.4	588.4	686.5	784.6	882.6	0
10	980.7	1078.8	1176.8	1274.9	1373.0	1471.1	1569.1	1667.2	1765.3	1863.3	10
20	1961.4	2059.5	2157.5	2255.6	2353.7	2451.8	2549.8	2647.9	2746.0	2844.0	20
30	2942.1	3040.2	3138.2	3236.3	3334.4	3432.5	3530.5	3628.6	3726.7	3824.7	30
40	3922.8	4020.9	4118.9	4217.0	4315.1	4413.2	4511.2	4609.3	4707.4	4805.4	40
50	4903.5	5001.6	5099.6	5197.7	5295.8	5393.9	5491.9	5590.0	5688.1	5786.1	50
60	5884.2	5982.3	6080.3	6178.4	6276.5	6374.6	6472.6	6570.7	6668.8	6766.8	60
70	6864.9	6963.0	7061.0	7159.1	7257.2	7355.3	7453.3	7551.4	7649.5	7747.5	70
80	7845.6	7943.7	8041.7	8139.8	8237.9	8336.0	8434.0	8532.1	8630.2	8728.2	80
90	8826.3	8924.4	9022.4	9120.5	9218.6	9316.7	9414.7	9512.8	9610.9	9708.9	90
100	9807.0	9905.1	10003.1	10101.2	10199.3	10297.4	10395.4	10493.5	10591.6	10689.6	100

	Kilo pascal to kilogram per square centimeters										
Kpa	0	100	200	300	400	500	600	700	800	900	Kpa
	Kg/cm2	Kg/cm2	Kg/cm2	Kg/cm2	Kg/cm2	Kg/cm2	Kg/cm2	Kg/cm2	Kg/cm2	Kg/cm2	
0	0.000	1.020	2.039	3.059	4.079	5.099	6.118	7.138	8.158	9.177	0
1000	10.197	11.217	12.236	13.256	14.276	15.296	16.315	17.335	18.355	19.374	1000
2000	20.394	21.414	22.433	23.453	24.473	25.493	26.512	27.532	28.552	29.571	2000
3000	30.591	31.611	32.630	33.650	34.670	35.690	36.709	37.729	38.749	39.768	3000
4000	40.788	41.808	42.827	43.847	44.867	45.887	46.906	47.926	48.946	49.965	4000
5000	50.985	52.005	53.024	54.044	55.064	56.084	57.103	58.123	59.143	60.162	5000
6000	61.182	62.202	63.221	64.241	65.261	66.281	67.300	68.320	69.340	70.359	6000
7000	71.379	72.399	73.418	74.438	75.458	76.478	77.497	78.517	79.537	80.556	7000
8000	81.576	82.596	83.615	84.635	85.655	86.675	87.694	88.714	89.734	90.753	8000
9000	91.773	92.793	93.812	94.832	95.852	96.872	97.891	98.911	99.931	100.950	9000
10000	101.970	102.990	104.009	105.029	106.049	107.069	108.088	109.108	110.128	111.147	10000

	Torque				Foot pounds to Kilogram meters						
	0	1	2	3	4	5	6	7	8	9	ft lbs
	Kg-m	Kg-m	Kg-m	Kg-m	Kg-m	Kg-m	Kg-m	Kg-m	Kg-m	Kg-m	
		0.138	0.276	0.414	0.552	0.690	0.828	0.966	1.104	1.242	
10	1.380	1.518	1.656	1.794	1.932	2.070	2.208	2.346	2.484	2.622	10
20	2.760	2.898	3.036	3.174	3.312	3.450	3.588	3.726	3.864	4.002	20
30	4.140	4.278	4.416	4.554	4.692	4.830	4.968	5.106	5.244	5.382	30
40	5.520	5.658	5.796	5.934	6.072	6.210	6.348	6.486	6.624	6.762	40
50	6.900	7.038	7.176	7.314	7.452	7.590	7.728	7.866	8.004	8.142	50
60	8.280	8.418	8.556	8.694	8.832	8.970	9.108	9.246	9.384	9.522	60
70	9.660	9.798	9.936	10.074	10.212	10.350	10.488	10.626	10.764	10.902	70
80	11.040	11.178	11.316	11.454	11.592	11.730	11.868	12.006	12.144	12.282	80
90	12.420	12.558	12.696	12.834	12.972	13.110	13.248	13.386	13.524	13.662	90
100	13.800	13.938	14.076	14.214	14.352	14.490	14.628	14.766	14.904	15.042	100

	Kilogram meters to Foot pounds										
	0	1	2	3	4	5	6	7	8	9	Kg-m
	ft-lbs	ft-lbs	ft-lbs	ft-lbs	ft-lbs	ft-lbs	ft-lbs	ft-lbs	ft-lbs	ft-lbs	
		7.230	14.470	21.690	28.930	36.170	43.400	50.630	57.870	65.100	
10	72.300	79.530	86.770	93.990	101.230	108.470	115.700	122.930	130.170	137.400	10
20	144.600	151.830	159.070	166.290	173.530	180.770	188.000	195.230	202.470	209.700	20
30	216.900	224.130	231.370	238.590	245.830	253.070	260.300	267.530	274.770	282.000	30
40	289.200	296.430	303.670	310.890	318.130	325.370	332.600	339.830	347.070	354.300	40
50	361.500	368.730	375.970	383.190	390.430	397.670	404.900	412.130	419.370	426.600	50
60	433.800	441.030	448.270	455.490	462.730	469.970	477.200	484.430	491.670	498.900	60
70	506.100	513.330	520.570	527.790	535.030	542.270	549.500	556.730	563.970	571.200	70
80	578.400	585.630	592.870	600.090	607.330	614.570	621.800	629.030	636.270	643.500	80
90	650.700	657.930	665.170	672.390	679.630	686.870	694.100	701.330	708.570	715.800	90
100	723.000	730.230	737.470	744.690	751.930	759.170	766.400	773.630	780.870	788.100	100

	Kilogram meters to newtonmeters										
	0	1	2	3	4	5	6	7	8	9	Kg-m
	N-m	N-m	N-m	N-m	N-m	N-m	N-m	N-m	N-m	N-m	
		9.810	19.610	29.420	39.230	49.030	58.810	68.650	78.450	88.260	
10	98.100	107.910	117.710	127.520	137.330	147.130	156.910	166.750	176.550	186.360	10
20	196.200	206.010	215.810	225.620	235.430	245.230	255.010	264.850	274.650	284.460	20
30	294.300	304.110	313.910	323.720	333.530	343.330	353.110	362.950	372.750	382.560	30
40	392.400	402.210	412.010	421.820	431.630	441.430	451.210	461.050	470.850	480.660	40
50	490.500	500.310	510.110	519.920	529.730	539.530	549.310	559.150	568.950	578.760	50
60	588.600	598.410	608.210	618.020	627.830	637.630	647.410	657.250	667.050	676.860	60
70	686.700	696.510	706.310	716.120	725.930	735.730	745.510	755.350	765.150	774.960	70
80	784.800	794.610	804.410	814.220	824.030	833.830	843.610	853.450	863.250	873.060	80
90	882.900	892.710	902.510	912.320	922.130	931.930	941.710	951.550	961.350	971.160	90
100	981.000	990.810	1000.610	1010.420	1020.230	1030.030	1039.810	1049.650	1059.450	1069.260	100

	Newtonmeters to Kilogrammeters										
	0	10	20	30	40	50	60	70	80	90	N-m
	Kg-m	Kg-m	Kg-m	Kg-m	Kg-m	Kg-m	Kg-m	Kg-m	Kg-m	Kg-m	
0	0.000	1.020	2.040	3.060	4.080	5.100	6.120	7.140	8.160	9.180	0
100	10.200	11.220	12.240	13.260	14.280	15.300	16.320	17.340	18.360	19.380	100
200	20.400	21.420	22.440	23.460	24.480	25.500	26.520	27.540	28.560	29.580	200
300	30.600	31.620	32.640	33.660	34.680	35.700	36.720	37.740	38.760	39.780	300
400	40.800	41.820	42.840	43.860	44.880	45.900	46.920	47.940	48.960	49.980	400
500	51.000	52.020	53.040	54.060	55.080	56.100	57.120	58.140	59.160	60.180	500
600	61.200	62.220	63.240	64.260	65.280	66.300	67.320	68.340	69.360	70.380	600
700	71.400	72.420	73.440	74.460	75.480	76.500	77.520	78.540	79.560	80.580	700
800	81.600	82.620	83.640	84.660	85.680	86.700	87.720	88.740	89.760	90.780	800
900	91.800	92.820	93.840	94.860	95.880	96.900	97.920	98.940	99.960	100.980	900
1000	102.000	103.020	104.040	105.060	106.080	107.100	108.120	109.140	110.160	111.180	1000

Temperature	Fahrenheit to Centigrade				Centigrade to Fahrenheit			
˚F	˚C	˚F	˚C		˚C	˚F	˚C	˚F
−20	−28.9	95	35.0		−30	−22.0	36	96.8
−15	−26.1	100	37.8		−28	−18.4	38	100.4
−10	−23.3	105	40.6		−26	−14.8	40	104.0
−5	−20.6	110	43.3		−24	−11.2	42	107.6
0	−17.8	115	46.1		−22	−7.6	44	111.2
1	−17.2	120	48.9		−20	−4.0	46	114.8
2	−16.7	125	51.7		−18	−0.4	48	118.4
3	−16.1	130	54.4		−16	3.2	50	122.0
4	−15.6	135	57.2		−14	6.8	52	125.6
5	−15.0	140	60.0		−12	10.4	54	129.2
10	−12.2	145	62.8		−10	14.0	56	132.8
15	−9.4	150	65.6		−8	17.6	58	136.4
20	−6.7	155	68.3		−6	21.2	60	140.0
25	−3.9	160	71.1		−4	24.8	62	143.6
30	−1.1	165	73.9		−2	28.4	64	147.2
35	1.7	170	76.7		0	32.0	66	150.8
40	4.4	175	79.4		2	35.6	68	154.4
45	7.2	180	82.2		4	39.2	70	158.0
50	10.0	185	85.0		6	42.8	72	161.6
55	12.8	190	87.8		8	46.4	74	165.2
60	15.6	195	90.6		10	50.0	76	168.8
65	18.3	200	93.3		12	53.6	78	172.4
70	21.1	205	96.1		14	57.2	80	176.0
75	23.9	210	98.9		16	60.8	82	179.6
80	26.7	212	100.0		18	64.4	84	183.2
85	29.4				20	68.0	86	186.8
90	32.2				22	71.6	88	190.4
					24	75.2	90	194.0
					26	78.8	92	197.6
					28	82.4	94	201.2
					30	86.0	96	204.8
					32	89.6	98	208.4
					34	93.2	100	212.0